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A Study of California Grape Culture

Horticulture


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A STUDY OF CALIFORNIA GRAPE CULTURE

BY

FRANK WHITCOMB PUSEY

THESIS

FOR THE

DEGREE OF BACHELOR OF SCIENCE

IN

HORTICULTURE

IN

THE COLLEGE OF AGRICULTURE

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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

Frank Whitcomb Pusey

ENTITLED A Study of California Grape Culture

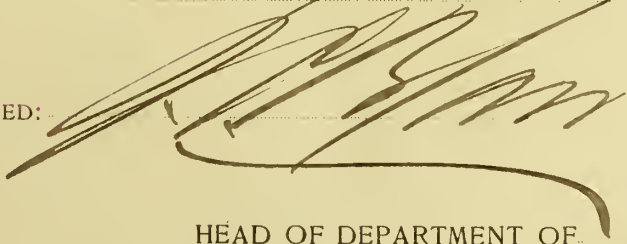
IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE

DEGREE OF Bachelor of Science in Horticulture

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CHAPTER 1.

INTRODUCTION.

Vitis vinifera is the oldest known species of the grape. The original home of the grape was probably around the Caspian Sea, but seeds found among the remains of the Swiss Lake Dwellers, and entombed with the mummies of Egypt, show that *Vitis vinifera* was known to these ancient peoples.

The products of the grape occupied an important place in the menu of the ancient Greeks and Romans, and many writers mention its use and culture. Perhaps the best account is that given by Pliny, for it is so practical that it may still be read with profit by the modern grape grower.

The old world grapes are grown for wine, and have higher sugar and solid content than do the American grapes that are grown mostly for the table. Because of the richness of sugar the European grape makes finer wine, and is more adapted to the making of raisins than is the American grape. It has better and larger bunches, better berries, and produces more fruit to the acre than do our varieties. The bunches stand shipping better, do not shell so easily, have less skin, and the skin separates from the seeds more readily.

The vines of the old world grape are stouter, make a shorter and smaller growth, and require less pruning. They are adapted to more different kinds of soil, and are more easily propagated by cuttings than are the American varieties. The European grapes, however, are very subject to *Phylloxera*, a root louse, and they may only be grown with safety

where they are grafted upon stocks of the American varieties, all of which are somewhat immune from this pest.

The American grape was first mentioned by the Norsemen in 986 A.D., but little or nothing was known of it until in 1565 an Englishman, Captain John Hawkins, visited the Spanish settlements in Florida, and described the varieties of grapes grown by the colonists.

The first grapes that were planted in this country were probably those planted by the Spanish padres at the old missions in what is now New Mexico, Arizona, and California. These were undoubtedly varieties of *Vitis vinifera* for the padres had been accustomed to the growing of grapes in Spain, and subsequent results have shown that the European grape will flourish in the warm dry climate of Southwestern United States.

In Eastern United States the first attempts at grape growing were made with improved varieties of *Vitis vinifera*. For a period of over a hundred years attempts were made to introduce the European grape into Eastern America. The effort, time, and money, spent in trying to adapt *Vitis vinifera* to these conditions were all wasted. The causes for the failure were Phylloxera, mildew, and rot, which kill the *Vinifera* grape. Furthermore, the fleshy roots are more tender and susceptible to cold than are the roots of the American varieties; and this has helped to prevent the culture from becoming general in any region where the native varieties could be grown.

West of the Rocky Mountains *Vitis vinifera* thrives, but does best only when planted on stocks of native varieties. Planting in this way controls the Phylloxera, and tends to increase the natural vigor of the scion when proper stocks are selected.

There are from thirty to fifty species of the genus *Vitis* in the world, and more than half of these are grown in the United States. It has distributed itself all over this country, and has become much modified because of the struggle for existence. The different varieties of grapes show many differences in size of vines, manner of growth; some being adapted to climbing, and others best adapted to low bushy growth on rocks and sand. Some of the varieties are no longer lived than a bush, while others will live for two or more centuries.

The study of the distribution and evolution of the American grape leads to the following conclusions, viz.

1. The species are so distributed over the United States, and individuals of the species grow in such abundance and luxuriance, as to suggest that we shall be able to improve, and domesticate one or more of them for all of the agricultural regions of the country.

2. Grapes are planted by nature and yield readily to improvement. They hybridize readily, and there are indications that some of the characters of grapes, at least, follow Mendel's law.

It was only after the American grape grower in eastern

United States realized that he could not grow the *Vinifera* grape that he turned to the improvement of the native varieties. He found that the wild grapes responded generously to proper culture, and that the improvement of the grape was rapid. It was resistant to the indigenous pests that had prevented successful culture of the European varieties, and could stand the severe cold of winter without serious injury.

The Concord, Catawba, Hartford, Isabella, and most of the American wine grapes came from the native Northern Fox Grape *Vitis Labrusca*. Some of these varieties were due to artificial crosses, but most of them originated from chance seedlings.

It is in the warm valleys west of the Rocky Mountains that we see the greatest development of the grape industry in America. Here the *Vinifera* grape reaches its greatest perfection in the United States, and the practice of grafting it on the stocks of resistant American varieties has rendered it particularly immune from most of the insect pests and fungus diseases that attack the roots.

There are several reasons why the grape thrives in California better than in most other parts of the country. The climate is mild, there are long seasons of warm weather suitable for the proper ripening of the fruit, and the freedom from rain during the summer furnishes ideal conditions for drying and curing the fruit. The climatic conditions in the grape growing districts of the State approximate somewhat closely those found in the grape growing centers of Europe;

thus the viticulturist on the Pacific Coast has been able to adapt the European varieties and methods of culture to the warm valleys west of the Rocky Mountains. This has enabled him to take advantage of the hundreds of years of grape culture in Europe, while the grape grower in Eastern United States has been compelled to develop his varieties from the wild grapes indigenous in that part of the country.

According to the 1910 census, California had two-thirds of the bearing vines in the United States, and produced more than three-fourths of the total grape crop of 1909. The value of the industry was estimated at \$10,846,812. The wine and grape juice production for the same year amounted to 16,006,000 gallons, and the raisin and dried grapes aggregated 169,210,679 pounds.

The increasing price of land, the long haul to the markets of the East, and the keen competition of Western fruit with the locally grown products in these markets, has compelled Western fruit growers to adopt the most approved methods of production.

Since it is known that the general farm practice throughout the country follows somewhat behind the progress made by agricultural experiment stations, and specialists in the several lines, it is the writer's desire to collect and present in condensed form in this thesis, some of the facts which the Viticulturist should know before attempting to grow grapes in California.

CHAPTER II.

Soils for the Grape in California

Though the soils of the State are predominantly light, deep, and rich, and thus well fitted for fruit growing, there are many degrees in the possession of these characters in local soils; and in regard to these individual characters they rate all the way from perfection to defectiveness.

Light Deep Loams. - Admixture of clay with enough coarse materials to secure permeability to air and water; ease in cultivation, deep root penetration, and free drainage of superfluous water, are characters that should be sought in a grape soil. These soils include a wide variety of materials, but agree in possessing striking adaptability to fruit culture.

Loams of the Valley Plains. - The east side of the Sacramento Valley forms a gently undulating plain consisting of an admixture of red foot - hill soil. This soil reaches from 6 to 10 feet in ^{depth,} and is underlaid by gravelly substrata. The width of this class of fertile valley land, east and west, varies considerably with the meanderings of the river. Sometimes farther back from the river it is clayey or gravelly, but in general it is free working fairly representative light loam.

In the San Joaquin Valley there is a greater admixture of sand. These plains loams vary in appearance, and are from this fact locally named "reddish loams", "white loam", "white ash", and similar names. Even in the case of the "white ash",

which is inert and made up of 90% sand, it is so deep, and has its plant food in such highly available condition, that it is producing very large crops of fruit where there is no rise of the bottom water to prevent root penetration.

The soils prevailing in the valley of Southern California from Redlands to Los Angeles are of a granitic nature. These mesa lands are conspicuous for their orange red tint, and the red sandy loams of which they are composed, range in depths varying from 10 to as much as 80 feet. Farther up the valley where the Santa Ana River has washed this red soil away, there is a gray and black loam of great depth and productiveness; underlaid by the enormous gravel beds that hold the water of this region.

Where the surface descends gradually to the sea shore, there are, as in Los Angeles and in Orange Counties, coast flats several miles in width where the soil is a dark colored sandy loam, glistening with mica, and more or less affected with alkali in the lower portions. Similar tracts are found in greater or less extent up the coast as far as Santa Barbara. As a rule these sea shore lands are very productive, but fruits for them must be chosen with reference to their low level, and exposure to coast influences.

The light loams of the so called desert region of Southern California are not inferior to some of the best soils of the great valleys except in the matter of humus content.

The valleys of the seaward slope of the coast range have mostly gray, light, and silty, rather than sandy soils, quite similar in appearance from Ventura to Humboldt County. In

such a country the soil surface shows wide diversity within a smaller areas than in the great interior valley; consequently, so far as soil goes, the coast forms are often suited to a wider range of fruits than the interior valley forms of similar size.

Alluvial or Sedimentary Soils. - These deposits occur along the beds of existing streams, and extend back to variable distances until they merge into valley lands or adobes. These deposits are considerably higher than the present beds of the streams, and are sometimes discribed as "next to river bottom". They consist of fine alluvium with seldom any admixture of coarser materials.

These soils cross the valleys in varying courses, and differ as to depth. In the valleys of the rivers crossing the east side of the San Joaquin Valley there are soil areas of brown or blackish loam. These soils are for the most part easily tilled, and exceedingly rich. The occasional introduction of alkali is the chief obstacle in the general approval of these alluvial lands for fruit purposes.

Soil of similar character is found in some small valleys, consisting of an alluvial wash from the bordering hills; which in some places reaches a depth of 30 feet or more without notable change. Such soils have proved very fertile and durable.

The rich river bottom adjacent to the beds of the main rivers and sloughs of the valley, has usually a dark, rich, and moist soil, easilly tilled, and not subject to baking and cracking. Care must be exercised in the selection of plants

which can stand to have their roots submerged for considerable periods of time.

In the coast valleys of the State there are also very extensive areas of alluvial soil, as well as upland loams formed in place by the disintegration of local rock formations. The famous fruit region extending from Oakland southward for nearly one hundred miles has very large areas of alluvial soil, ranging from deep, rich blackish loams resulting from intermixture of sediment brought down from adjacent hillsides by streams, with the clay of the valley bottom. It is these deep, rich, alluvial deposits that make the region so famous for fruit growing.

Clay Loams. - These soils contain sufficient clay to render them tenacious, and their suitability for grapes depends upon selection of roots adapted to their character, and upon the depth and degree of retentiveness. They are more difficult to till than the loams, but are very rich and durable.

The soils of the foot hills of the Sierra Nevada vary from a moderately clayey loam to a heavy, though not uncommonly gravelly, orange red clay. The soils are highly charged with iron to the extent of seven to twelve per cent, which being finely divided imparts to them the orange red tint. The soils of the foot-hill agree with the soils of the valley in having a good percentage of lime; while the supply of potash and phosphates, as well as of organic matter is smaller, and sometimes low, though never apparently inadequate for present productiveness in the presence of so much

lime.

Along the base of the foot-hills, there is in Fresno, Tulare, and part of Kern counties, a narrow belt of partly red and partly black clay or adobe, so highly calcarous as to break up when dry into small fragments. A white calcarous marl sometimes occurs beneath this soil at varying depths. This is defective because of its impervious nature which does not allow good drainage, and therefore kills the roots thru suffocation and acid production. Westward of this land there is a belt of reddish brown soil, corresponding to those similarly located in the Sacramento Valley, but generally more clayey, and hence frequently designated as adobe by contrast with the very sandy soils of the valley at large, altho properly they should be classed simply as clayey loams. The soil is a reddish more or less sandy loam, changing little in its aspect for several feet.

Clay Soils. - Thus far only a small area of adobe soil has been employed in horticulture. Its color varies as the popular terms "black waxy," "black," "brown," and "gray" indicate. The black adobe on the east side of the Sacramento Valley is easily tilled as compared with the gray adobe on the west side, which is very refractory, and often largely impregnated with alkali. Adobe soils are as a rule rich and durable, and therefore promise long fruitfulness to trees and vines with roots adapted to heavy soils, but difficulty of cultivation, excessive retention of water, and other evils are always present.

Soils for the Grape. - There are thrifty vineyards on

the light deep valley loams, on the heavy clay loams, on adobe, and on the red soils of the foot-hills. Even on shallow soils the grape will do well if given sufficient moisture, and on rocky subsoils it thrives if there are crevices for the roots to penetrate. Standing water during the active period of growth is unfavorable to growth, and alkali is unfavorable to satisfactory growth in wine making. Almost any soil which does not hold excess of moisture, or is not tainted with alkali will do for the vine, altho the plant appreciates good deep soils, and will bear fruit in proportion to the supply of it. The economic question of ease of cultivation enters into the question of choice of soils for the grape, and must be taken into consideration in choosing a sight for a vineyard.

CHAPTER III.

Location of the Vineyard.

If the immediate sea coast, and the higher altitudes on the mountains be excepted, the grape may be planted with a good chance of success anywhere in California, if soil and topography are suitable. In planting grapes in doubtful situations much depends upon choice of varieties. In the cool air of the coast range, and the short summer of the higher altitudes, early maturing varieties must be the main reliance, for late sorts will not have heat enough to bring them into full maturity.

Away from immediate influences, and up to perhaps three thousand feet or more, on the sides of the Sierras, the grape is successfully grown on the floor of the valley, and on the hillsides. The coast valleys of the upper part of the state produce good table grapes, but they are unfavorable for the raisin industry because of the deficient sunshine, and the excessive atmospheric humidity of the autumn months. The best raisins are made in the dry valleys of the interior, but conditions that are desirable for raisin production develop an undesirable degree of sugar in the wine grape. Although the valleys yield large quantities of grapes, they can not compete with those raised on the hill sides in point of quality. Here enters the business proposition whether large quantity is better than less

amount and higher quality. Answer to this question depends upon disposition of the crop, and the demand for it.

The coloring of certain varieties is a matter underlying their profitable production for fresh shipments, and is determined by local conditions concerning which the best information is local observation of their effects.

Topography. - As a rule the ideal location for a vineyard is one that is somewhat elevated above adjoining lands. This situation gives proper elevation for atmospheric and land drainage. Cold air being heavier than warm air, in still weather settles into the lowest areas, often causing late spring or early fall frosts. This elevation does not have to be great, or the land rolling to accomplish air drainage; for, a comparatively slight elevation is often sufficient to accomplish perfect atmospheric drainage. The more pronounced elevations usually give better results.

Bodies of water have a large influence upon fruit production in that they tend to keep the temperature lower in the spring, and higher in the fall. This is a marked advantage in the prevention of late spring and early fall frosts. Other things being equal high lands near rivers and lakes are most desirable.

In spite of this fact much of our best fruit lands are on low flat areas, but in these cases the grower should avoid low places surrounded on all sides by elevated land, for such situations are pockets in which the cold air collects. Vines planted in these low places will often suf-

fer when surrounding areas are uninjured.

Generally speaking, in frosty regions the vineyard should slope toward the north, or the northwest, for such an exposure will have a tendency to retard the blossoming of the early varieties. On the other hand, if the grower desires an early, well colored grape, he should select a southeastern exposure which will give the maximum amount of sun.

Air Drainage and Winds. - As a rule winds are beneficial to vineyards only when they bring warmer air, or when they keep the air in motion in frosty weather. In dry regions there is a special reason for wishing to check the winds, from the fact that they abstract so much water from air and plants. Even a slight wind-break may give marked results in the conservation of moisture. L. H. Bailey observes that evaporation was 24% greater 300 feet from a wind-break than it was 20 feet from the same point.

Wind has a great effect upon frost for it may leave some vineyards unharmed, and nearly ruin the crop in others, while even in portions of the same vineyard these extremes have been noticed. This is probably chiefly due to the eddies of air, for even though air seems to be almost quiet it is still in uneven motion. Instances have been noticed in California vineyards where frost has injured groups of three or four vines in different parts of the vineyard, or may attack an acre or two, and leave the rest uninjured.

The range of elevation through which the atmospheric

drainage acts beneficially to the vineyard is limited. A fall of a few feet in a plantation is often sufficient for the very best protection from light frosts, and a fall of one or two hundred feet may be regarded as the general maximum throughout which the benefit may be observed, for very high elevations are bleaker and colder in summer temperature than comparatively low ones.

Wind-breaks .- Fruit growers seem to be somewhat divided as to there ⁱⁿopinions concerning the advantages of wind-breaks. Some growers have long stretches of Poplar, Pine, and Eucalyptus trees planted along the irrigation ditches, or on one side of their vineyards, while others will only plant a border of fruit trees, or insist upon no trees. There are many advantages, and some disadvantages to wind-breaks; and the particular location of the vineyard, as well as the elevation will be important factors in determining whether a wind-break is advisable.

It appears that a wind-break is desirable where the fruit plantation is exposed to strong winds; but care should be exercised to see that there is sufficient circulation of air. The prevailing winds, particularly where they are strong, are the ones which are chiefly to be avoided.

Some of the advantages claimed for the wind-break are-

1. They may protect the vineyard from cold.
2. Reduced evaporation from the surface of the soil, thus tending to mitigate drought in summer, and root injury in winter.

3. Protects the blossoms from severe winds:

more than negatively so.

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And a number of their friends, or invited guests in France, visited us in their homes, commencing the celebration of their fiftieth birthday. These friends have long enjoyed the privilege of being invited to the home of the President and Mrs. Grant, and have been invited along the last of the month, and on the day of their birthday, this others will only find a number of their friends, or invited guests in France.

There are many advantages, and some disadvantages to this method, and the particular merits of the method, as well as the situation will be important factors in determining its applicability.

IT systems are not a silver bullet

strong, and the new which are offered.

Some of the advantages claimed for this system

1. They say I forgot the window key.

2. Reduced vegetation from the surface of the soil.

There is no doubt that the above findings are significant in showing that the use of the word "and" in the phrase "and in fact" is not a mere formality, but a substantive part of the contract.

4. Prevents fruit from injury by being blown about.

5. Sometimes causes the fruit to ripen earlier in certain localities.

Growers who do not favor the wind-break are often in situations where there is little danger of strong winds during the blossoming or fruiting periods, and hence can have but little use for one. The following objections, however, may be raised in regard to wind-breaks in general.

1. Wind-breaks may render the plantation colder at certain times; for, when warm winds come in the spring the wind-break tends to deflect them over the vineyard.

2. Fruit immediately adjacent to the wind-break is apt to be small in size, and inferior in color.

3. Vines close to wind-breaks may be less thrifty than others.

4. There may be great danger of late spring frosts in sheltered plantations.

5. The quantity of water that may be transpired by a row of large trees during a season is very large, and unless there is an abundant supply of water, the ground may dry out too quickly and injure the vines.

Water Drainage.- Lands which have good natural drainage are best for fruit because they are warm, give up their fertility easily, and allow very early cultivation. If this natural drainage does not exist tile drains should be used until the soil is brought into the best possible condition.

Rolling lands as well as the flat lands often need drainage.

In California where the soil is light, and is penetrated by the roots of plants to a much greater depth than in the humid regions, the loss of feeding area for the plants by improper drainage, which prevents deep penetration of the roots, is obvious. In irrigated districts the use of too much water, or the leakage of water from a ditch, will often raise the water level close to the surface. This gives the plants but a very narrow feeding area, and means that the available plant food in the narrow layer of top soil will soon be exhausted and that heavy fertilization will have to be resorted to. Furthermore, the upward movement of this water carries with it large quantities of alkali salts that may render the soil totally unproductive. It will be seen, therefore, that in many cases proper drainage may not only mean larger crops, but may be essential to the production of any crops at all.

Irrigation.- This subject will be taken up more fully in a chapter devoted to irrigation. It may be said that irrigation works best, and is easiest when there is a gentle slope from the source of water supply to the area that is to be irrigated. The grower will find that his efforts in leveling and grading the land before planting will be well repaid in the greater ease, and cost of labor saved in irrigation after the vines have been planted out.

Location With Referance to Markets.- Altho the California producer is in a large way dependant upon eastern

In California where the soil is light, and is very-
fertilized by the waste of plants to a much greater depth than
in the South, where the loss of fertility is the
cause of the rapid exhaustion of the soil. In California the
top of the rocks is covered with a thin layer of soil, and
will often show the grey level of the rocks. This
shows the plants have a very narrow feeding area, and
that the available plant food in the narrow strip of top
soil will soon be exhausted, and that heavy fertilizing
will have to be resorted to. Therefore, the system of
water of this water system with its large quantities of the
oil will show that the soil is very rich and fertile.
It will be seen, therefore, that in many cases proper
use can not only save much money, but can be essential
to the production of any crop at all.

Investigation. - This subject will be taken up here briefly
in a chapter devoted to irrigation. It may be said that
irrigation is not new, and is practiced when there is a
lack of water from the source of water supply in the area that
is to be irrigated. The farmer will find that the water
is being used for the best of the land, and that the
will result in the greatest use and most of labor saved in
the irrigation of the crops. The water is being used
in the most efficient manner possible. - This is the
method of irrigation in a large and important area.

markets for the consumption of the fruits that he raises; yet the railroads and local markets should be taken into consideration in the selection of the location for a vineyard. To have the choice of two or more means of shipping- as by rail or water, or by more than one railroad- is a most desirable feature in the location of any vineyard. This is not only because competitive rates may be secured, but because more markets may also be reached.

Then too, the grower who is in close proximity to several towns may often dispose of his produce without incurring the heavy expense incumbent upon growers who cater to Eastern trade. This may enable the small grower to utilize his time to good advantage in developing and supplying a local trade for such fruit as he produced.

Location with Referance to Other Growers.- When fruits are to be grown for markets that are several thousand miles away , and great expenditure for picking and shipping are necessary, it will be seen that there are many advantages in community action. One grower could hardly expect to make any impression on a market as large as Chicago, for instance, even though he were able to ship two or three cars of fruit a week, if he were the only grower in his locality, but where many growers are engaged in shipping the same kind of fruit, and a steady stream of cars enter the Eastern market from some particular point, this is bound to attract the attention of the Eastern buyer. The railroads bid more freely for the privilege of carrying the freight, and the producers of crates , baskets, etc. are more ready

[illegible]

Then had the Green who in those days was
several times as often witness of his presence within the
walls of the city as he was of his presence without. The
fact that the Green was a man of the city was a fact
which was well known to all. This was a fact which was
well known to all. This was a fact which was well known
to all. This was a fact which was well known to all.

[illegible]

to make better prices.

If one is to grow grapes for Eastern shipment he should endeavor to locate his vineyard close to the railroad or packing shed, for handling or jolting of the fruit after being picked greatly impairs its shipping qualities, and long hauls over rough roads, even where springs are used on the wagons, means that the grower will have a much larger amount of cull fruit returned to him, and that such as is shipped will not carry so well because of bruises caused by the long haul. This means lower prices to the grower for the buyer is anxious to secure a brand of fruit that is known to have good keeping qualities.

The vast throng of men and women who follow the seasonal work along the Coast will flock in at harvest time, and help may be secured much more easily than if a single isolated vineyardist were trying to grow fruit.

The man who produces wine grapes should consider the location of his vineyard with reference to a winery, or several wineries if possible. The long haul when fruit is beginning to ripen rapidly will force the grower to hire extra teams at a time when they are hard to secure. This may result in heavy loss from the drying of the fruit, for some varieties of wine grapes dry very rapidly after they reach maturity, and a grower who is selling by the ton, can ill afford to let his fruit dry on the vines.

[illegible]

The first thing I saw when I stepped out of the car was a man in a dark suit, looking at me with a serious expression. He was standing in the middle of the street, and I could see other people in the background, but they were out of focus. The man in the suit walked towards me, and I followed him. He led me to a building that looked like a government office. Inside, there were several people sitting at desks, and a man in a uniform was talking to one of them. The man in the suit introduced me to the man in the uniform, and they both looked at me. The man in the uniform then led me to a room where a man in a suit was sitting at a desk. He looked at me for a moment, then he stood up and walked towards me. He shook my hand, and then he led me to a car. The car was a dark sedan, and it was parked in front of the building. The man in the suit got into the car, and I got into the back seat. The car started moving, and I looked out the window. I could see the building and the street, but I was too focused on the man in the suit. He was looking at me, and I could see his eyes. He was a man in a dark suit, and he was looking at me with a serious expression. I was sitting in the back seat of a car, and I was looking out the window. I could see the building and the street, but I was too focused on the man in the suit. He was looking at me, and I could see his eyes. He was a man in a dark suit, and he was looking at me with a serious expression. I was sitting in the back seat of a car, and I was looking out the window. I could see the building and the street, but I was too focused on the man in the suit. He was looking at me, and I could see his eyes. He was a man in a dark suit, and he was looking at me with a serious expression.

CHAPTER IV.

Selection of Varities of Grapes.

After having selected a proper sight for the vineyard, it is necessary to consider how we shall plant it out. Will it be advisable to grow only one variety, or shall we grow several, endeavoring to plant varities that will ripen at different periods during the season; thus enabling us to ship grapes throughout the summer? If we do this we shall have to consider other growers, for we would not be able to grow sufficient fruit to pack our own cars; and so, if we plant varities that ripen too early it may mean that we shall have difficulty in disposing of the fruit.

Then too, a shipping grape must have certain qualities which have eliminated many varities that would be desirable for local consumption. First, it must be attractive, for it is known that the average buyer consults his eye to a very large extent in the selection of fruit. The grape, then, that makes a good appearance upon the market, other things being equal, will be the one that will bring the best price. Secondly, the grape must be a good shipper, and have good keeping qualities, for from one to four weeks may elapse from the time that the grape is picked until it is consumed. The buyer in the East gets to know the varities of grapes that show the best keeping qualities, and pays the best price for those brands which have both richness, and desirable keeping

qualities.

The grower is not restricted to one variety, however, for there are the early ripening varieties such as the Thompson Seedless and Malaga, and the later grapes, as the Tokay and Emperor. These grapes have definite seasons and good certain limits, to ship when the market is strongest.

Some vineyardists have grown grapes which may be used in two or more ways. Thus the Thompson Seedless, which is one of the earliest grapes, may be shipped and put on the market as a table grape, or it may be allowed to accumulate more sugar and be dried to make raisins. Some of the black grapes are suitable either for a wine or table grape. Most of these grapes, however, are very much better when put to one use than to the other. Thus the Thompson Seedless makes an excellent raisin grape, and commands high prices when it reaches Eastern markets early; but as soon as the Malagas, and other larger grapes begin to enter the markets in considerable quantities, the price of these grapes drops very materially. The grower usually picks the best grapes for shipping, and this means that the smaller bunches have been left on the vines for drying purposes, and will decrease the general quality of his raisins.

In considering the table grape alone for the vineyard, one should realize that he is utilizing but one of the three principal uses to which grapes may be put; the other two being for raisins and wine purposes. He is depending principally upon the Eastern market to consume his entire crop.

In this kind of an enterprise the grower is dealing with a perishable green fruit that must be shipped each day in limited quantities, for it can not be held over in the markets for a more favorable time to sell. Therefore , if the market is glutted, as it often is in the middle of the shipping season, the grower receives but little for his fruit, and may sustain considerable loss. Then too, this fruit competes in the eastern market with the locally grown fresh fruit, and unless the consumer particularly likes the California grapes, he will purchase the locally grown fresh fruit of some other kind.

The three standard shipping varieties are the Malaga, Emperor and Tokay. They have become generally better known than most other varieties of California grapes, and find a better market in their respective seasons. Other varieties that are not so well known involve somewhat of a risk, for it is not at all certain just how they will be received in the market, because a local grocer is not anxious to burden himself with fruit that his customers are not acquainted with.

The raisin industry is a very important part of grape growing, and the increased utilization of raisins throughout the country as a whole , has stimulated the production to a great extent. There is usually a steady demand for them, and as a rule the price that the grower gets for them is adequate; although at times, combinations, and bad management on the part of distributing agents have rendered the

The first part of the paper is devoted to a general

discussion of the various methods of determining the

relative positions of the various parts of the

system, and the results of the various experiments

which have been made in this connection.

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industry unprofitable. The raisin may be kept for one or more years in good condition, and thus the grower is able to take advantage of a rise in prices for a considerable time after the raisins are made.

The warm valleys of the interior are particularly suited to this industry, for here the long seasons of hot weather give proper conditions for ripening and drying of the fruit. The coast valleys are too cool, and are subject to fogs that make curing of raisins difficult ; while in the northern valleys the temperature is not sufficiently high, nor the season long enough to permit proper sun curing of the fruit.

In general, the Muskatel, Thompson Seedless, and Sultana , are the principal raisin varieties. The richness and largeness of the raisin makes the Muskatel the choice raisin grape of the San Joaquin Valley, and the interior valleys generally.

The Thompson Seedless is the principal seedless grape of California, and has far outstripped the Seedless Sultana in popularity. As the name indicates, it is usually without seeds, and produces abundance of fruit when planted in proper soil.

The yields of raisins from these grapes vary from one half, to one and one-half tons to the acre, but a ton to the acre may be taken as a good average yield.

Wine grape growing is the third important branch of viticulture in the State and the prospective vineyardist should consider carefully the advantages of setting a portion

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The following is a list of the names of the persons who have been appointed to the various positions in the Department of the Interior, and who have been sworn in as such.

The results of studies from these agencies have been
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of his vineyard out in wine grapes. The wine grape does not require so much care as do table or raisin grapes, harvesting is easier since all of the fruit can be utilized, the fruit does not require the careful handling that other kinds of grapes do, and when they are delivered to the winery, the grower has fulfilled his part of the contract. He can calculate beforehand about what his returns will be, while in the case of shipping grapes, he is not certain, and may lose heavily if he strikes a poor market.

Altho there have been many varieties of wine grapes tried in and about Fresno, which is the principal wine making center in California, and in fact in the United States; the two varieties which are now most generally grown are the Zinfandel, or black wine grape, and the Feher Szagos, or white wine grape. They will grow on almost any soil suitable for grapes, but prefer the lighter more sandy soils. Here they yield abundant crops and mature early. The chief objection to them is that after reaching maturity they are inclined to dry very rapidly, and are quite subject to mildew.

For the grower who sells his grapes so much a ton, the question resolves itself into "Which is the heaviest bearer?" For the good of the industry at large, it is advisable that varieties should be planted which will produce as large a crop as is compatible with such quality as will maintain and extend the market for California wine. Cheap wines can be produced for profit only from heavy bearing varieties grown in rich soil, and wines of the highest quality only

from fine varieties grown on hill sides , or other locations where the crops are necessarily less. It is equally unwise to plant poor bearing varieties in the rich valleys where no variety can produce a fine wine. No variety which is not capable of yielding from 5 to 8 tons in the valley, or from $1\frac{1}{2}$ to 3 tons on the hill side should be considered.

Some combinations of varieties which have given good results in different parts of the state are as follows-

Vineyards for sweet wine in the interior valleys.

Red	Proportion
Grenache	$\frac{1}{2}$
Alicante Bauschet	$\frac{1}{4}$
Tinta Madeira	$\frac{1}{4}$
White	
Polomino	$\frac{1}{2}$
Beba	$\frac{1}{4}$
Boal	$\frac{1}{4}$

The Grenache and Alicante Bauschet are heavy bearers with short pruning. The former naturally takes a port flavor, and the latter insures sufficient color. The Tinta Madeira, when pruned properly bears well, and will insure the quality of the Port wine.

The Polomino is one of the heaviest and most regular bearers grown in California, and peculiarly suited for Sherry making. The Beba bears nearly as well as Polomino and is of better quality. The Boal bears good crops, and and gives a sweet wine of high quality.

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 system is not a simple one. It is a
 complex one, and it is not possible to
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 possible to describe it in a few words.

Part	Function
1	Control
2	Control
3	Control
4	Control
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6	Control
7	Control
8	Control

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Vineyard for Dry Wines in the Interior Valleys

Red	Proportion
Valdespenas	$\frac{1}{2}$
Lagrain	$\frac{1}{4}$
St. Macaire	$\frac{1}{4}$

White

Burger	$\frac{1}{2}$
West's White Prolific	$\frac{1}{4}$
Vanacria Sarda	$\frac{1}{4}$

Vineyards for Dry Wines in the Coast Counties

Red	Proportion
Petite Sirah	$\frac{1}{2}$
Beclan	$\frac{1}{4}$
Cabernet Sauvignon	$\frac{1}{4}$

White

Semillon	$\frac{1}{2}$
Colombar	$\frac{1}{4}$
Sauvignon Blanc	$\frac{1}{4}$

Vineyards for Dry Wines in the Cooler Parts of the
Coast Counties

Red	Proportion
Beclan	$\frac{3}{4}$
Blue Portuguese	$\frac{1}{4}$

White

Franken Riesling	$\frac{3}{4}$
Jonnishberg Riesling	$\frac{1}{4}$
Wine grapes Recommended for California	

For the Coast Counties

Department

Year

1

1900

2

1901

3

1902

1903

4

1904

5

1905

6

1906

1907

Department

Year

1

1907

2

1908

3

1909

1910

4

1911

5

1912

6

1913

1914

1915

Department

Year

1

1915

2

1916

1917

3

1918

4

1919

1920

1921

Red Wine Grapes

Petite Sirah

Cabernet Sauvignon

Beclan

Tannat

Serine

Mondeuse

Blue Portuguese

Verdot

White Wine Grapes

Semillon

Colombar

Sauvignon Blanc

Franken Riesling

Johnnishberger

Traminer

Peverello

For Interior Valleys

Red Wine Grapes

Valdespenas

St. Macaire

Lagrain

Gros Mansenc

Barbera

Refosco

Pagadebito

White Wine Grapes

Burgor

West's White Prolific

Vernaccia Sarda

Marsanne

Folle blanche

For Sweet Wines

Red Wine Grapes

Grenache

The best wine grapes for California as a whole are-

Alicante Bouschet

Tinta Madeira

Calif. Black Malvoisie

Monica

Mission

Maurastel

White Wine Grapes

Polomino

Beba

Boal

Perruno

Montno

Mourisco branco

Pedro Ximenez

1. The first thing I noticed	was the smell of the sea.
2. It was a strange smell	that I had never before.
3. It was a mix of salt and	something else.
4. I had never before	experienced this.
5. The smell was so strong	that it was almost
6. Overpowering.	
7. It was a smell that	was both familiar and
8. Strange.	

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In some parts of the State the amount of color in the grape is insufficient for the quantity of red wine which it is desired to make. Varities which contain sufficient color in one locality may be deficient in others. Thus Carignane Grenache, Maurastel, and Aramon , contain sufficient color in the coast counties, but can only be used for white wine in the hot^ter valleys unless blended with color grapes.

In the San Joaquin Valley the best grapes for color of those commonly grown in the State are, St. Macaire, Gros Mansane, and Barbera. Only these varities along with the Refosco have retained enough color to permit them to be mixed with other wines. The three varities mentioned have an increased degree of acidity which gives them a freshness that make them very valuable in this district for dry red wines.

Grapes for Dry Wine in the San Joaquin Valley,- In general the varities which produce the desired results in the coast region, fail to produce the desired results in the hot interior. Varities that might be used successfully for Port in this Valley , are Zinfandel, Alicante Bouschet, Carbono, and Carignane. Those that do not produce good dry wines anywhere in the State are Grenache, Mataro, Mission, Trouseau, Chauche Noir, and California Black Malvoisie.

Of all varities tested by the experiment station in the interior valleys, the Valdepenas seems to be the best for dry wines. It produces large crops of fine grapes with short pruning, is not subject to sunburn or black mold, and the grapes remain on the vines for a considerable time with-

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out injury. The wine made from it is of a superior quality. If only one variety were to be planted for dry red wine in the upper San Joaquin Valley, this is the one that would be chosen. Other varieties which have been recommended for dry red wines in the upper San Joaquin Valley are, Lagrain, which contains color and quality, and Macaire, Gros Mansenc, Barbera, and Pagadebito, which have color and acidity. The Burger seems to be particularly suited to this region, and the Johannisberg and Franking Riesling, have also given very good results.

In our selection of varieties we must consider first the possibility of the largest net returns, and in doing this we come face to face with the proposition, " Shall we plant wine grapes, table grapes, or raisin grapes; or shall we plant some of each of the three classes of grapes". The vineyards that have been devoted to one class of fruit are relatively scarce, and are usually in connection with a winery, or owned by some one who is associated with one of the other lines of the grape business, where he is able to dispose of that particular grape to advantage.

If we look over the field of viticulture, we see that most of the growers do not depend upon one particular kind of grape, but practice diversified grape culture, usually growing some of each kind of grape. In this way they are able to offset low prices received for one kind of grape, by the higher prices received for the other two, thus making their yearly income approximately the same. for each year. Of course the kind of soil, the climate, and similar factors

[illegible]

must be taken into consideration before deciding upon varieties, but in general, a diversity of fruit which will give the grower the widest possible market for his produce, will in the long run be the most desirable.

It seems advisable at this point to give a short description of some of the most important raisin and table grape varieties grown in California. The most important table grapes are,*-

Black Malvoise,- Vine a strong grower, wood long-jointed, rather slender, light brown ; leaf medium size, oval, five lobed, upper surface smooth, lower surface light tomentose on the veins; bunches large, rather loose, branching; berries large, oblong, reddish black; flesh juicy; flavor neutral.

White Muscat of Alexandria,- Vine a short , rather straggling and bushy grower; wood gray with dark spots, short jointed; leaf round, five lobed, bright, green above, light green below. The laterals produce a second, and even a third crop; bunch long and loose, shouldered; berry oblong, light yellow, transparent, covered with white bloom, fleshy, with thick skin. The leading table grape of California.

White Malaga,- Vine a strong grower; wood reddish brown, short jointed; leaf medium, leathery, smooth, deeply lobed, light shiny green above; bunch very large, loose shouldered, long; stem long and flexible; berry very large, oval, yellowish green, covered with white bloom, thick skin , fleshy.

Flame Tokay,- Vine a strong grower, large in all of its
* J. Wicksen--California Fruits. pp. 371--374.

proportions; wood dark brown, straight with long joints; leaves dark green with a brownish tinge; lightly lobed; bunch very large, sometimes weighing eight to nine pounds, moderately compact, shouldered; berry very large, oblong, red, covered with fine lilac bloom; fleshy and crackling; ripens late.

Black Hamburg,- Bunches very large, from six to ten inches in length, very broad in the shoulders, tapering to a point gradually ; berries very large, round, slightly inclined to oval; skin rather thick, deep purple, very black at maturity; very sugary, juicy, and rich.

Purple Cornichon,- Vine a heavy grower, with thick, dark, short-jointed wood; Leaves large, longer than wide, deeply five-lobed, dark green above, and lighter, and very hairy below; bunches very large, loose on long peduncles berries large, long, more or less curved, darkly colored and spotted, thick skinned, and on long pedicels.

Emperor,- Vine a strong vigorous grower; leaves very large with five shallow lobes, glabrous above, woolly beneath, light green in color; bunches very large, long conical, loose with large dull purple, oval, firm berries. Seems best adapted to interior situations, and is chiefly grown for shipping in the San Joaquin Valley.

Gros Colman,- Vine strong growing with dark brownish wood; leaves very large, round, thick, very slightly lobed, shortly and bluntly toothed, glabrous above, close woolly below; bunches large, short, well filled, but not compact; berries very large, round, dark blue, with thick but tender

skin. Remarkable as having the largest berry of any round berry variety known, and is probably the handsomest black table grape grown.

The raisin grapes which are most widely grown in the State are,-

Muscatel Gordo Blanco,- vine low and spreading, with no upright branches in the center; clusters heavy, and when perfect, close and shouldered; berries , large and round, a crease often being found at the apex of the berry; color green, or when fully ripe, amber green or yellow. The Muscatel is the choice raisin grape of the San Joaquin Valley, and for the interior generally.

Sultana,- vine vigorous, upright; leaves large, five-lobed, with rather large sinuses, light colored, and coarsely toothed; bunches large, long-cylindrical, with heavy shoulders; berries small, round, firm, and crisp, golden yellow, and without seeds.

Thompson's Seedless,- Vine very vigorous, with large trunk and very long canes; leaves glabrous on both sides, dark yellowish-green above, and light below, generally three lobed with shallow sinuses , teeth short and obtuse, bunch large conico- cylindrical, well filled or herbaceous peduncles; berries under medium, ellipsoidal, crisp or neutral flavor, with moderately thick skin of a golden yellow color.

The following table shows the results of the analysis of variance for the different groups of subjects. The results are given in the form of a table.

The table shows that the results of the analysis of variance are highly significant. The results are given in the form of a table.

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CHAPTER V.

Propagation of the Grape

The grape is propagated either from seeds, layers, or by cuttings. There is little need of growing from seeds, however, for the large number of European varieties which it is possible to utilize makes such a practice unnecessary. Likewise, the use of layers for securing new vines is but little used, for it is very easy to obtain vines by cuttings since the *Vinifera* species roots so easily. Growing vines from cuttings is the prevailing method both to secure grafted stocks, and to grow vines on their own roots. In growing the cuttings they are either placed in the permanent place in the vineyard, or set out in the nursery row to be transferred to the vineyard as rooted vines.

The tendency seems to be at present to use rooted vines instead of cuttings to plant out the vineyard, for altho the first cost of growing the rooted vines is much greater than for cuttings, the better stand, and hardier growth obtained from rooted vines, more than makes up the difference.

Budding and Grafting the Grape

Working over the grapes is largely practiced in California. There are two reasons why this is done; first, by this method undesirable varieties may be replaced by those of better quality, or better market demand; second, the roots of the *Vinifera* variety can be replaced by roots

which resist the phylloxera.

Grafting over an old vine is a simple operation and may be done by any of the following methods.

Green Cleft Graft,- This is an ordinary cleft graft made on the green shoots of very young vines. The shoot used as stock is cut between the second and third leaves counting from the apex, and one and one-half or two inches above the third leaf. The scion is a smaller shoot the leaves of which are pinched. The ligature is wool or raffia, and must be removed as soon as it begins to cramp the joint. This graft is exposed to drying.

Harwath Graft,- This graft is made by inserting a scion bud in the place of an eye, and is commonly used in fruit tree ; but the excision of a bud on the vine can not be done in the same way because of the considerable protuberance existing at each node.

A circular incision penetrating the whole depth of the bark is made one-third inch above, and another the same distance below the bud. Then on the right and left of the bud, two longitudinal parallel incisions are made joining the annular ones. The bud thus prepared should be placed on a shoot of as nearly as possible the same diameter as that from which it was taken. The indispensable point is that the bud must be placed or inserted in place of another bud on a node.

After determining where the bud is to be placed the leaf is removed. Two semi- circular incisions are made at the same distance as on the scion , and a single long-

itudinal cut is made passing thru the bark dividing the petiole in two, and joining the annular incisions. Then with the spatula of the grafting knife, the bark is lifted on both sides; the scion is inserted and the flaps are joined and ligated. A fortnight or twenty days after this the binding is cut off. This graft is a long and delicate operation.

Salgues Graft,- On any internode of a shoot to be grafted a longitudinal incision is made with the grafting knife penetrating the whole depth of the bark, and about the depth of the shield. The shoot is bent over so as to open the lips of the slit, the scion bud is inserted, and the shoot is left to spring up to the former position. The scion bud is compressed by the bark, and the operation is completed by tying. The ligature should be removed a fortnight or twenty days afterward. The scion buds should be taken from those buds in which the diaphragm is already well apparent, but on a part of the shoot where the white pith is not noticeable. It is necessary to tie the grafted shoots to a stake as they are thus better protected and do not dry out so quickly as when close to the ground. This graft is simple, gives perfect union, and is of great value in re-establishing vineyards on resistant stock.

Bessom Graft,- This graft is made in spring at the same time as the ordinary bench graft. A special pair of shears is used that cuts and lifts the bud, the same operation being made on stock and scion canes. On the stock the second eye, counting from the top of the cutting is cut out;

while for the scion any one of the eyes on the cane is used. The cutting to be grafted should be 16 inches in length, the top being limited to a bud cut half way in two. The graft is tied with raffia. So far this graft tried on green shoots has not been a success, but on the ripe canes the results have been very good.

Clarac Graft,- In the Clarac graft a bud is also substituted for a bud. On the stock an incision is made an eighth of an inch above a bud, and continued in a straight section parallel to the axis of the cane, penetrating one-third of the diameter. The cut is stopped when the length is a little over the width of the blade below the base of the bud. The blade is removed, laid flat on the cane immediately under the base of the bud, in order to indicate by the width of the blade the point where the new transverse and oblique incision is about to be made, to prevent the first section from spreading, and to make a strong notch for the scion to rest upon.

The scion bud is obtained in the same way, placed on the stock and tied.

Another way consists in not removing the bud on the stock, only the longitudinal cut being made. The scion bud is made in the same way but with a longer bevel; it is inserted in the slit prepared on the stock and tied. The bud left on the stock constitutes a sap drawer which facilitates the drawing of the scion bud.

Selection of Shoots Bearing Buds to Use for Scions,- Choose shoots that would normally remain dormant until the

following year, also those of medium diameter. The diameter of the shoots from which the scion bud is taken must always be a little smaller than the diameter of those upon which it is to be grafted. The best shoots are light green ones that have been developed in the shade.

The petioles of the leaves of the shoots should be of whitish green. Shoots bearing leaves of deep green or reddish brown petioles should be rejected. The eyes at the extremity and base of the shoots; together with those placed at the base of the leaves having a very slender or very long petiole should not be used.

Preparation of the Scion Buds,- The whole of the petiole, and part of the limb of the leaf should be left when the leaf is pinched, if the petiole is not shorter the bud dries out. The same bud may be made with sap wood and half sap wood; the latter is by far the best.

Scion with Sap Wood,- After the bud has been cut out the shield will be about one and one-half inches long; and as it will have a clipped edge it is advisable to smooth it down. This will reduce it to about one inch in length. The sap wood of the shoot does not knit, therefore, it is advisable to diminish its surface.

Scion with Half Sap Wood,- The cut is started in the same way but the knife is drawn parallel to the axis of the cane. By drawing the blade out the transversal section is made, care being used to cut thru the bark only. The bud is lifted and pulled back. As the transverse section only goes thru the bark, in lifting the bark a tongue of sap wood

remains attached to the cane, and adheres to the scion bud. This is broken off leaving a two pronged fork. If the fork is not formed the bud should be rejected as the wood is not ripe enough.

Making the Slit in the Stock,- In one or two year old canes the slit should be made on the round part where the bark is thicker. If the scion bud has a little sap wood attached, it is best to place it on the flat side.

Ligatures,- The best are made of lead or tin foil tied with raffia, or cotton. The tin foil is cut in pieces $\frac{3}{4}$ of an inch wide, and 2 or 3 inches long.

Arrangement of the Mother Stock,- All shoots of American stock may be easily budded. A person can place from 10 to 20 buds on a vigorous cane, and obtain the next season from one vigorous mother vine, from 100 to 150 grafted cuttings. As soon as the shoots of the mother stock are about 20 inches high, eight to ten are retained and the balance disbudded. The shoots are tied up in V shape as soon as hard enough, and all auxiliary buds and tendrils are removed. This is repeated three times during the season. The even numbered shoots are tied up on one side, and those of odd numbers on the other. Twice the amount of wood fit to be budded is obtained in this way.

Gathering and Keeping the Budded Cuttings,- The cuttings should be made from the canes after the leaves have fallen; the whole cane should not be cut off, and then the cuttings be removed later, because they are apt to be bruised by being treated thus. As the cuttings are gathered the eyes

of the stock are removed . The good ones are placed in cases in layers separated by fresh moss or moist straw. The cases are placed in a close, dry, frost proof room. When the boxes are taken into the nursery the cuttings are taken out one by one, and their upper end freshened with a grafting knife, (not shears), $\frac{3}{4}$ to one inch being removed at each end. The cut end is then coated with tar.

RESISTANT CUTTINGS

Some of the chief causes of failure in unsuccessful grafted vines are,-

The use of a resistant species which is unsuited to the soil and climate of the locality. Resistant varieties are all derived from one or more varieties indigenous in the United States, east of the Rocky Mountains. These species are much more difficult to suit than the European wild vines.

The use of an insufficient resistant variety. Stocks vary from almost complete resistance to non resistance.

The use of unselected resistants. When the first resistants were selected the wild stocks were chosen. These vary greatly in degree of resistance . It is necessary to use a well chosen resistant stock.

Grafting the resistant vines when too old. The younger the tissues the more complete and lasting the union. If the stock and scion are each one year old, as in cutting grafting, the union is nearly always good. No wood older than one year is ever used as a scion, but the stock is often much older. If the stock is more than one year old many

varieties fail to give good unions, and if three or four years old, a large number of the grafted vines will fail after they have produced one or two crops.

Planting or grafting too deep. The result of this is that the scions form their own roots and finally become independent of the resistant stock which dies. The vine may continue to grow well if phylloxera is not present, but it is not resistant.

Union between the resistant stock and the scion can be brought about by : 1. The scion cuttings may be grafted on the resistant cuttings , or on resistant roots in the work-shop before being placed in the nursery. This is called "bench grafting".

2. The resistant cutting may be first rooted in the nursery, and the next year grafted in place with out removal. This is called "nursery grafting".

3. The resistant cuttings or roots may be planted directly in the vineyard, and the next year, or some subsequent year may be grafted. This is called "field grafting", "vineyard grafting", or "grafting in situ".

These methods are all adapted to different conditions, but the one that has given the most general satisfaction is the first.

THE NURSERY.

Choice and Preparation of the Soil,- The high cost of grafted vines is due partly to the skill necessary in producing them, but also, to a great degree to the large number

of grafts which fail to grow, or make a satisfactory union in the nursery.

While there are many causes for the failure of some of the grafts to grow, probably the most important of these is the nature of the soil in which they are rooted. Any soil which cakes on the top after rain or irrigation, will cause the failure of many grafts. A soil which becomes very compact will prevent the shoot from pushing its way through, and so cause the death of the graft. Stony soil, soils which dry out too quickly, and wet soils are all unsuitable for the nursery. The ideal soil for a nursery of bench grafts, is a light well drained sandy loam containing an abundance of humus. It should be carefully graded so as to have no high or low spots. The physical nature and condition of the soil is of more importance than the chemical composition. The soil should not be poor; but neither should it be too rich. A plant of medium size, good roots, perfect union, and a growth of from 15 to 18 inches is the best.

At least two months before planting, the soil of the nursery should be thoroughly prepared. All weeds, stones, and rubbish should be removed, and the ground well plowed to a depth of at least 18 inches, in order to aerate and pulverize the soil to promote quick rooting. Unless the roots of the stock start almost as soon as the scion, the latter will dry out as soon as the little leaves begin to evaporate water.

Soils which are defective should be fertilized. Well rotted manure is useful, but the best fertilizer for the

purpose, is a good crop of field peas, or legume, plowed under the previous autumn sufficiently early to insure its complete decay before planting time.

Cutting Grafts,- The scion cuttings should be taken only from healthy vines which are known to have produced good crops. Cuttings showing signs of serious attacks of Oidium, Vine Hopper, or other fungi and insects, should be rejected. The cuttings used should be of medium size, firm, with light colored pith, and short to medium joints. The best size is about one-third of an inch in diameter. Any cutting under $\frac{1}{4}$ inch, and over $\frac{1}{2}$ inch, is not to be used.

All the precautions regarding the health and maturity of the cuttings, and the vines from which they come, apply equally in this case. The most important point in this case, however, is that they are unmixed, and true to name. If the stocks are mixed there is no easy^{way} of detecting it, and the result will probably be a vineyard of unequal growth, in which many of the vines will be unprofitable. The size of the stock cuttings must be the same as that of the scion, since they have to be accurately matched.

Planting and Cultivation of the Mother Vines,- The choice of varieties to plant will depend upon what the market demands. If the demands change, it is always possible to graft the stocks with other varieties of resistant to meet the changed conditions. The land should be given the same treatment recommended for the planting of grafts.

The most promising varieties for general use at present, seem to be the two hybrids of *Riparia* and *Rupestris*. They

have great resistance to phylloxera, root and graft almost as easily as St. George, and are quite sufficiently vigorous to support any variety of Vinifera. The former is more suited to the moist soils, and wherever there is danger of root-rot; and the latter to the drier soils.

In pruning the mother vines, the object is to produce as much wood as possible, and to reduce the production of fruit wood. In accordance with the idea, the mother vines are often pruned in such a way as to force out an abundance of water sprouts from the old wood. All the canes on the vine are cut off as close to the stump as possible. This produces a large number of small water-sprouts unsuitable for stocks.

A better way is to give the vine a trunk and head exactly as in pruning ordinary vase formed vines. A trunk 15 to 18 inches high, and with 5 to 6 arms, will make a vine much more easy to cultivate and prune, and equally as productive of good cuttings. Very short spurs consisting simply of the base bud are left. The canes should be cut off thru the first bud above the base bud.

During the spring and summer, all unnecessary shoots should be removed in order to throw all the vigor of the vine into those that remain. A good strong vine should produce 150 to 300 feet of good grafting wood .

Some varieties of stocks produce good grafting wood if the canes are allowed to grow over the surface of the ground without support. A practical method is to put a stake about ten feet high at the end of each row, and to stretch a

wire at that highth along the row. The shoots are then trained to ^{the} wire by means of strings.

Making and Conserving the Cuttings,- Cuttings may be taken from the vines at any time between the fall of the leaves in the autumn, and two-weeks before the swelling of the buds in the spring. They may be used as soon as made, or kept for an indefinite time, provided they are given proper care. The canes may be taken from the vines and stored in a shed for as long as a couple of weeks. The scion cuttings are made in lengths of from 18 inches to 3 feet, and tied in bundles of from 106 to 150. If they are to be used in the vineyard they may be tied loosly in bundles and placed in a sand pile under a shed, or in an under-ground cellar.

The ~~sand~~ in which the cuttings are placed should be fairly dry. If too dry the cuttings will dry out, but the chief danger is that it will be too wet, and in this case the cuttings will rot. If a handful of sand is taken it should not form a ball when squeezed, and should not leave the hand moist.

Cuttings to be used for stocks should be handled in the same way , except that it is preferable to cut them into lengths varying from 8 to 15 inches , according as to whether long or short grafted plants are wanted. In planting in very dry soils, or on hill-sides, long cuttings are wanted, but as a rule a cutting of 10 inches is quite long enough, since a longer cutting is more difficult to handle in the nursery. The stock cuttings should be kept dormant, but a slight

swelling of the buds is not serious. If the scion bud has commenced to swell it should not be used, but if the stock has started it may be used provided the bark has not become loose.

Time of Grafting,- Cutting grafts may be commenced in California by the first of January, or a little sooner, but the best results are obtained by grafting in February and March. The work may be continued through April, and even into May if the cuttings can be kept dormant.

Preparation of Stocks,- The making of the stocks is the same as the making of the scions in all essentials. The cut at the bottom of the stock should be made in such a way as to leave the diaphragm. The top cut should then be made as near 10 inches as possible, but leaving about $1\frac{1}{2}$ inches of inter-node above the top bud. This is necessary for convenience in grafting.

The next process is the disbudding of the stocks. If this is done properly it decreases greatly the number of stock suckers which will appear in the nursery, and which must be removed. With *Riatria* it is only necessary to remove the top bud, but with varieties such as *Rupestris* St. George it is also necessary to cut more deeply, and remove the woody enlargements at the base of the bud, for here are located a number of dormant buds. Every bud on the stock including the bottom bud should be removed.

Preparation of the Scions,- Scions may be of one or two buds. With one bud scions there is an advantage in that every scion is of the same length. This makes it possible to

have all unions at the same distance below the surface in the nursery. The only advantage in two bud scions is that in ground which bakes on top, it is possible to have the top bud above the surface of the ground, and yet have the union sufficiently deep to prevent drying out. The scion should be cut with about $2\frac{1}{2}$ inches between the inter-node below the bud, and at least $\frac{1}{2}$ inch of inter-node above the top bud.

Grading the Cuttings,- For best results the stock should be of exactly the same diameter as the scion. If the cuttings are not sorted beforehand, the grafter loses a great deal of time in looking for scions to fit the stocks. For this reason a mechanical gauge for sorting the scions has proved a great time saver. The commonest kind is the notch-grader. This consists of a brass plate 12 inches long, and 2 inches wide, in which are made 6 or more notches. Each of these differ from the one next to it by one-sixteenth of an inch, and they usually vary from $\frac{4}{16}$ to $\frac{10}{16}$ inch. In using the grader every cutting should be measured thru its largest diameter.

The green bark on small cuttings is thinner than that on large ones, but in all it is just about $\frac{1}{6}$ of the diameter of the whole. If, therefore, the smallest scion in any grade is grafted on the largest stock of the same grade, the outer edge of the bark of the scion will be in contact with the inner edge of the bark of the stock. This brings the growing surfaces sufficiently near to form a good union.

Method of Uniting Stock and Scion,- Tongue Grafting; When the stocks and scions are prepared and graded, the grafter takes a box of scions and one of stocks of the same size and unites them. Each is cut at the same angle in such a way that the cut surface of one, exactly fits and covers the whole of the cut surface of the other. The length of the cut surface should be from three to four times the diameter of the cutting, the shorter cut for the larger size, and the longer one for the smaller grafts.

The tongues are made with a slow sliding motion of the knife . They are commenced slightly above $\frac{1}{3}$ of the distance from the sharp end of the bevel, and cut down until the tongue is just a trifle more than $\frac{1}{3}$ the length of the cut surface. The tongue should be cut, not split. Before withdrawing the knife it is bent over in order to open up the tongue. The stock and scion are now united, and if everything has been done properly , there will be no cut surface visible, and the extremity of neither the stock nor the scion will project over the cut surface of the other. These are then tied with raffia or waxed string. For the formation of healing tissue air is necessary , so anything that will exclude the air should not be used.

Untreated raffia should be used for late grafts that are to be planted directly in the nursery, but if the grafts are to be placed first in the callusing beds , it is best to bluestone that raffia in order to prevent it from rotting before the grafts are planted. This is done by steeping the

bundles of raffia in a 3% solution of bluestone for a few hours, and washing the raffia before using.

Number 18 knitting yarn soaked in grafting wax for a few hours and then dried is also good. The wax is made by melting together 1 part of tallow, 2 parts of beeswax, and 3 parts of rosin.

Wire Grafting,- The advantage claimed for this method of grafting, is that it is quick, requires less skill, and does away with the trouble of tying . The scion also has less tendency to root than with the tongue graft. It consists essentially of a short piece of galvanized iron wire inserted in the pith of the stock and scion for the purpose of holding them together, and thus replacing both tongue and raffia. The preparation of stocks and scions is exactly the same as for the tongue graft method.

The stock and scion are cut at an angle of 45 degrees, and then a piece of galvanized iron wire 2 inches long is pushed one inch into the firmest pith, which will usually be the pith of the stock. The scion is then pushed on to the wire, and pressed down until it is in contact with the stock. With cuttings which have a large pith it is well to use two wires. Wire of 17 gauge is the most useful size.

Making Bundles,- It is advisable to put grafts in a callusing bed for several weeks before planting out. Between 10 and 20 grafts should be put in a bundle to facilitate handling.

Grafting Rooted Cuttings,- One may graft a scion cutting on a stock cutting which has been rooted in the nursery

the previous season. Resistant cuttings which are too small to graft become large enough the following year, but the principal use of this method is in producing grafts on stocks which root with difficulty. These unite easily with the scion, so that if we defer the grafting until the stock has rooted, we save the expense of making a large number of grafts which never grow. The same methods may be used in making the grafts with rooted stocks, as were used with the cuttings. The stocks are cut down to a uniform length, and the scions inserted on the original cutting. The scion should not be grafted to the growth of the previous year, for the numerous suckers produced would interfere with the uniting. The roots of the stock should be cut back to stubs not more than one inch in length.

Callusing,- The favorable conditions for the development of the graft do not exist in the nursery at the time the grafts are made; for this reason it is always best, except at the extreme end of the growing season, to "stratify" the grafts in a callusing bed where the conditions of moisture, temperature, and aeration, can be controlled.

The callusing bed may be a pile of clean sand, with boards around it, and surrounded by a ditch to permit drainage. It should be furnished with a movable canvas to protect it from the rain, and to enable the temperature to be controlled by the admission or exclusion of the sun's light.

The bottom of the callusing bed is first covered with two or three inches of sand; the bundles of grafts are then planted in a row, and sand well filled in around them. The

bundles should be placed in a slightly inclined position with the scions uppermost, and the sand should be dry enough so that it sifts in around the grafts in the bundles. The bundles are then covered to a depth of two inches with sand. Another ~~another~~ row is then placed in the bed until the bed is full. Finally, a layer of two or three inches of moss or straw is then placed over all.

The object of the callusing bed is to hasten the perfect union of stock and scion without allowing the roots or shoots to start growth. From 8% to 10% of water will be found to be sufficient in the soil. The temperature should be kept about 60 degrees or lower. About the middle of March the temperature should be raised. This is done by removing the cover on warm days, and carefully covering at night. The temperature of the sand should be 75 degrees at the level of the unions at this time.

At the end of the fourth week after warming the bed the unions should be well cemented. It should require a pull of several pounds to break the grafts, and when this stage has been reached, the grafts are in condition to be planted in the nursery. Shoots and roots may have started, but these should not be more than a half-inch long. It does not matter if these are broken off.

Planting in the Nursery,- The grafts are planted in the nursery wide enough apart to allow of horse cultivation, and wide enough apart in the rows to give each graft room to develop. The rows are planted 4 ' apart, and the grafts not closer than 3" apart in the row.

The number of grafts to the acre, and the space given to each, is shown in the following table;

Vines	Rows	No. Grafts per Acre	No. Sq. In. per Graft.
2 in.	36 in.	87,120	72
2 "	48 "	65,340	96
3 "	36 "	58,080	108
3 "	48 "	43,560	144
4 "	36 "	43,560	192

The grafts may be planted in a trench made with a spade, but it is better if they are planted with a dibble.

Before planting with a dibble a scraper should be used which will make a shallow trench, 12 to 18 inches wide, and about 2 feet deep, perfectly smooth and level at the bottom. A line is then stretched taught about one inch to one side of where the row is to be planted, and two inches above the bottom of the ditch. The grafts are then planted with the dibble, being put down to such a depth that the top buds come exactly level with the taut line.

When it is necessary to plant in compact soil, or soil containing pebbles, a dibble can not be used. Here a trench should be dug with one side slightly slanting. The grafts are layed against the side, and well pulverized soil shoveled into the trench. In heavy soil, a couple of inches of sand should be placed on the bottom of the trench. This will very much facilitate the rooting.

When the grafts are planted they should be very carefully covered with one or two inches of soil. This will leave the nursery with the unions in the



center of the ridges at the original level of the soil. The depression between the ridges should be about two inches below the level of the unions. This makes possible the irrigation of the grafts without injuring the unions with too much water.

Cultivation,- By the end of April, the grafts should be planted and well irrigated. This will start the roots growing. A cultivator should be run between the rows as soon as possible after irrigation, but the ridges should not be disturbed until the scion starts. In case of rain the ridge should be very carefully raked over. Until about the first or middle of July, there is nothing to do in the nursery but to keep the weeds down, and see that the scions do not become dry.

The shoots from the scions should appear in about two weeks after planting. The shoots are at first yellowish, but as soon as roots are formed they become a deeper green. The sides of the ridge should now be kept loose by hoeing, and the ground between the ridges pulverized by frequent cultivations.

Removal of Scion Roots,- As soon as the roots on the stock have started, the unions should be examined, and all roots which have started from the scion should be removed. This will be about the beginning of July in the warmer districts, and about the last of the month in the cooler. The scion roots are useful in helping the scion to start, but should not be left too long, for if left to develop largely, they take the food elaborated by the scion leaves.

and the stock roots are starved.

Removal of Raffia and Suckers,- At the same time that the scion roots are removed, the tying material is also cut on all of the scions. Any suckers which grow from the stocks should be removed as soon as they appear above the ground. The soil should be replaced, but the ridges are not made quite so high because this has the effect of hardening the unions.

Digging the Grafts,- The grafts may be removed from the nursery at any time after the leaves have turned yellow, and before they are needed for planting in the spring. It is best to wait until the leaves have fallen and the vines are dormant. Cutting the roots does no harm, but tearing them should be avoided. A nursery plant digger is one of the best tools to remove them with.

Sorting the Grafts,- When grafts are taken out of the ground, they should be sorted in three lots in accordance with their root and top growth, and especially with regard to the strength and completeness of the union. Number 1 grafts are planted in the vineyard; number 2 grafts are put back in the nursery; and cull grafts are rejected.

A number 1 graft should have a well ripened top 10 inches long, and well developed roots. It should not show large scars, should not show injuries in digging, and should have made perfect union on both sides.

The number 2 grafts are those which have some of the defects mentioned above, but which may develop into good vines.

Grafts which make a heavy top growth by means of scion roots, and of which the stock is small and starved, should be thrown away. Those in which the union is defective should also be rejected.

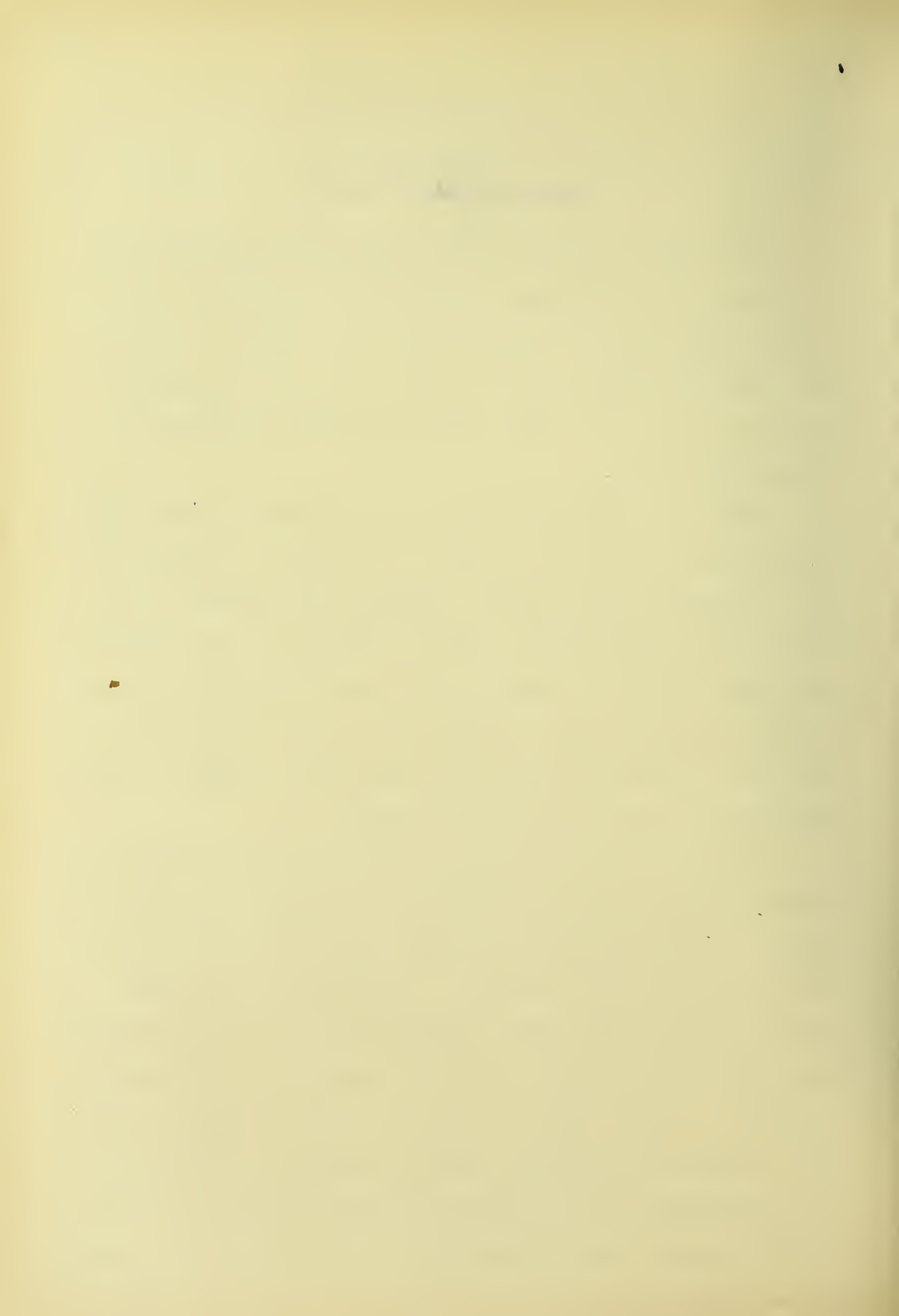
CHAPTER VI.

Planting the Vineyard.

After the location of the vineyard has been selected, it is of prime importance to see that the ground is put in proper shape before the young vines are planted. The vines will remain for years, and a little care in fitting the ground at the start, will save much time and expense in future operations.

First, if irrigation is to be practiced, it will repay the grower to see that the ground is properly leveled so that the water may be easily conducted in ditches, or in checks over the vineyard, without washing the soil away by its rapid flow. The number of men required to irrigate will be largely reduced, and the amount of ground covered in a day will be much increased if proper care is taken to level the ground before the vines are planted.

The direction in which the vines should be planted will depend somewhat upon the position of the particular piece of ground with reference to the main roads, and the slope of the ground; but the exposure to the sun, and the slope, should also be taken into consideration. By planting the rows east and west, the vines will, in a measure, be protected from the hot sun; while by planting north and south, they will receive the greatest amount of heat from the sun in the afternoon. In the interior valleys protection from the early afternoon sun is desirable, for the fruit is in danger



of being burned, especially before it has acquired any considerable amount of sugar.

In making plantings of any considerable size, it is advisable to provide for avenues so that teams may enter to carry out the fruit at harvest time, and to generally facilitate ease in vineyard operations. Altho practice varies considerably, it has been found very satisfactory to make an avenue every 24 rows by taking out one row of vines. In this way, the fruit that is picked will not have to be carried more than twelve rows of vines. Some vineyards are planted with an avenue every twelve rows, but this practice is not general. Twenty-four to thirty rows between the avenues is the rule. Care should be taken to have sufficient room on the sides of a planting to turn a team, or drive a wagon; for unless this is done, many of the vines on the outside row will be broken down, or injured by the cultural operations.

The distance between the vines, in rows will vary with the soil, the variety of the fruit, and the cultural operations. Perhaps the most general plan is to plant either 8x8 feet, or 8x10 feet. Lately, the growers seem to favor the latter method of planting, since it gives a larger surface for root development, and makes the cultural operations easier. In good soil, under proper cultivation, 8x8 foot plantings should give very good results.

Trellised vines should be planted far enough apart to allow plenty of room for summer cultivation, and it is probable that 10 or more feet is none too close for these vines.

Preparation of the Land,- The land which is to be planted in vines should receive very good preparation; this is particularly so in the case of the resistant vineyard, for the expense is greater than with other kinds, and the returns must, therefore, be quicker.

Wherever vines are to be planted, the soil should be plowed to a depth of two to three inches deeper than the bottom of the graft when planted, and subsoiled several inches below this. A plow which will turn the soil over to a depth of twelve inches followed with a subsoiler that will stir the soil six inches deeper, will give results during the first three years of the vineyard that will more than pay the cost in crops alone, besides leaving the vineyard in much better shape.

Fertilization,- Usually no fertilizer is needed the first year. When planting on the sight of an old orchard, or vineyard, fertilizer to renew the humus should be applied. A crop of peas or rye plowed under, or 15 to 20 tons of well rotted manure to the acre will be sufficient. If the manure is not well rotted, it is likely to do more harm than good. It should be spread evenly over the surface of the land, and plowed under.

In every case it is well to place a little nitrogenous fertilizer below each vine when it is planted. For this purpose two or three ounces of ground, steamed bone-meal, or half a shovelful of old stable manure may be used to advantage.

Unless there is an abundance of water during the summer for irrigation, there should be clean culture between the vines. If any crop is grown, it should be some kind of hoed crop planted during the first year.

Planting,- The planting of the vines in the vineyard is essentially the same as the method used in the nursery. If the ground has been properly plowed and is free from stones, the plantings may be made with a dibble. For this method the strong roots must be pruned down to a quarter of an inch, and the smaller roots removed entirely. The hole is made 8 to 10 inches deep according to the length of the graft. The graft is then inserted to the right depth, and the dibble pressed into the ground three or four inches from the graft, and a few inches deeper than the first time. By a vigorous thrust of the handle, the soil is pressed around the graft. Whatever the length of the graft, the union should be one or two inches above the general level of the ground.

In stony soils, or where fertilizers are to be used, the holes must be dug with a spade, and should be 4 inches deeper than the bottom of the graft. Care must be taken not to place the roots too deep, or the graft will root on the scion stock. If the scion roots are removed twice a year for the first two years, and once a year until the vines are seven or eight years old, this result may be avoided. The removal of these roots is difficult to accomplish, and it may be avoided by planting the grafts at the proper depth.

In general, it is found that the best position for the

union is about two inches above the surface of the ground. In planting with a dibble, one can estimate the height of the union with sufficient accuracy by using his eye, but when a hole is dug, a three foot stick laid across the hole, or a market rope stretched at the proper height will be necessary.

Pruning,- The top is usually pruned by removing all of the shoots except one; the superfluous shoots being cut so as to remove the base bud. The shoot that is left should be cut through a bud at the top.

Staking,- To obtain the best results, a vineyard of bench grafts should be staked the year that it is planted. Bench grafts grow a little faster than ungrafted vines, and with most varieties the scion will be a little larger than the stock. This will make the vine top-heavy and likely to bend over on the ground. To have a well shaped vine from the beginning, the shoot should be tied to a stake.

For ordinary short pruned vines, a stake 3 feet long, and 1 X $1\frac{1}{2}$ inches in diameter is large enough. This can be driven two feet into the ground and will support the vine for 5 or 6 years. If vines are to be headed 15 to 18 inches, a 4 foot stake $1\frac{1}{4}$ X $1\frac{1}{2}$ inches in diameter should be used.

FIELD GRAFTING.

Altho this method has been used to a considerable extent, it is in all cases less satisfactory and more expensive than the methods already described. A field grafted

vineyard is almost impossible to start on stony land, it is much at the mercy of the weather, and the cost is always more than similar vineyards started with bench-grafts.

Preparation of the Soil, - Thorough plowing and sub-soiling are even more essential when planting grafted vineyards. The stocks must make sufficient growth the first year to permit them to be grafted the following spring. If delayed longer, the wood becomes hard, and does not make a good union.

It is better to plant good cuttings than roots, because when they are planted the following year, the union is made a year younger in the case of the cuttings, and is correspondingly more perfect. Only firm, healthy, well ripened wood, sufficiently long to allow four inches of the top to be left above the surface of the ground, should be used.

The Age of Grafting, - Wherever possible the vines should be grafted the year after planting. Any stock which is one half inch thick, and has made a good top growth can be grafted. Whenever possible, the vine should be grafted at, or above the surface of the ground. For stocks up to two-thirds inch in diameter, the tongue or wire graft is the best. For larger vines up to three-fourths inch in diameter, a modification of the tongue is necessary. By cutting the bevel of the stock only part way through it is possible to make a smaller scion unite on both sides. For still larger scions, the ordinary cleft graft is the best.

Season for Field Grafting, - Field grafting in any case should not be commenced until the soil is dry enough, altho

in some cases this may be as early as March. Grafting may continue as long as the cuttings can be kept dormant.

Treatment the First Year,- Field grafts should be disturbed as little as possible for the first 2 or 3 months after being made, except that in July suckers and scion roots may have to be removed. It is best not to touch the scion roots until about the middle or end of July, when they should be removed with the same care exercised in the nursery. As the graft grows, it should be tied up to the stake.

Regrafting,- Altho 95% of the grafts made in this way have been known to grow, the usual number will be between 50 and 75 percent.

Regrafting must be done one joint farther down than the first grafting. This will usually bring the union below the surface and cause trouble with scion roots. Regrafting very seldom gives a strong healthy vine, and some believe it best to dig up the vines which have failed, and replace them with bench grafts.

CHAPTER VII.

Care and Pruning of the Young Vineyard.

The young vineyard after being set out, requires great care and constant attention on the part of the grape grower to keep the shallow rooted vines in a thrifty condition during the summer months. A sufficient amount of moisture at a depth where the young roots may obtain it is absolutely essential. Just what method is used to keep this water supply present will depend upon conditions. Where irrigation is possible water may be conducted between the rows ; but if it is not possible to get water to the vines in this way, it may be necessary to place a tank upon a wagon , and water them by hand. This is not a very satisfactory method, however, and should not be resorted to unless the conditions demand it.

Thorough cultivation is most essential in the young vineyard, both to conserve the moisture near the surface by creating a dust mulch, and to permit the easy penetration of the roots into the soil, thus enabling them to increase their feeding area. Thorough cultivation should follow every irrigation and if the conditions do not demand irrigation, the vineyard should be cultivated at least once every two weeks to maintain the dust mulch.

The care of the vines themselves is of prime importance, for the attention given the pruning, suckering, and training during the formative period of the life of the vine,

will determine largely its future productivity.

First Growing Season,- With cuttings, rooted vines, and grafts, where the growth will be moderate, staking the first year will be unnecessary. No pruning is done until the winter following the planting, except in the case of bench grafts. In this case in moist soils, scion roots should be removed early, so that they may not prevent proper development of the stock roots. In some cases where very vigorous vines are grown under the best conditions, it is advisable to disbud the vine, with the exception of the main cane, in order to concentrate all of the energy of the vine in this one shoot. In this case staking is necessary, and methods similar to those described for the second season are used.

First Winter Pruning,- Soon after the leaves have fallen in December, or early in January, the vines should be pruned. All the canes are removed entirely except one. This one should be well matured at the base, and should have well formed eyes. The cane should be shortened to two eyes, and all of the shallow roots within 2 or 3 inches of the surface of the ground should be removed. Some vines may have made exceptionally good growth, and may have a cane that is large enough to prune in the way that is described for the second year's growth.

Staking,- The stakes should be driven soon after pruning, and before the starting of the vines. All stakes should be driven on the same side, and about two inches distant

from the vine, so as not to injure the large roots. The direction of the wind during the growing season must be taken into consideration, for the stakes must be driven on the leeward side, i.e. the stakes must be tied so that the wind will press the vine toward the stake.

Second Summer Pruning,- By this time the vines have well developed root systems, and for this reason they require very careful attention on the part of the pruner. Vines neglected at this time, and in this way, may make as large a growth; but a large part of it will be wasted. The vines will be misformed; and it will require from one to two years longer to develop a suitable framework, and bring them into bearing.

The main object, during this second growing season, is to develop a single, strong, vigorous, and well ripened cane, from which to form the permanent cane of the vine. As soon as a shoot of a few inches has been developed, the vines should be disbudded by rubbing off with the hand, all the buds and shoots, except the two largest, and best placed. Leave only those that will grow a straight vine. When the largest buds have grown from 10 to 15 inches, they should be tied to the stake. If the first shoot is injured in tying up, the second shoot should be tied up, and the first one removed. After the vines have grown a foot or eighteen inches, they will need to be tied with a second string, placed three or four inches from the end of the shoot. If the cane is a very vigorous grower, the nodes will be too far apart to allow a proper distribution of the buds, and

there is danger of the cane breaking. These canes should be topped off level with the stake when they have grown several feet above it. Since the vines of this second year are very vigorous, they are apt to grow so late in the fall that they may be injured or killed by a frost. This is particularly so with the grafted vines. Late growth must be prevented, and the wood matured before frost if possible. Late irrigation should be avoided, and cultivation should stop by mid summer. This will retard growth, and enable the vines to ripen their wood properly. In very moist rich soils, it will be found advantageous to grow corn, sun-flowers, or allow the weeds to grow to take off the surplus moisture.

Second Winter Pruning,- In normal vines the pruning simply consists in cutting back the single canes which have been allowed to grow, to the height at which it is desired to head the vine. Only the buds on the upper half of the cane are allowed to grow. These buds should give about 6 bunches of fruit, and six to eight canes this year. In all cases a full internode should be left above the top bud. This is made in such a way as to destroy the top bud, but to leave the diaphragm intact. By making a half-hitch around the inter-node the vine is held very firmly, when it becomes heavy with leaves, and supple with the flow of sap. A second tie is always necessary between the top bud and the ground, but no kind of a hitch should be used, for this will have a tendency to girdle the vine.

Vines that have not made sufficient growth to be tied

up, should be cut back again to two buds, and care taken to develop a strong shoot the next summer. Canes should not be cut to intermediate lengths, for this results in variation in the height of the heads. Further care should be taken, not to allow any but the one main cane to develop.

Third Summer Pruning,- All the shoots below the middle of the cane should again be removed. The buds that are left should produce 8 to 10 bunches of fruit, and 4 to 5 canes. When the five shoots grow, the height of the head will be determined by the selection of certain of these canes for spurs. It is often desirable to leave some extra spurs lower than it is intended to head the vine, and to remove these spurs the following winter after they have borne a crop. During the spring it will be necessary to sucker and remove low shoots at least once more. In vigorous growing vines the shoots should be pinched when they are about 18 inches long.

Third Winter Pruning,- It is at this pruning that the arms of the vine are formed. These will depend upon the length and the vigor of the vine. Six spurs of two buds each will give the required number in a very vigorous vine. The pruner should leave enough fruit spurs to provide all that the vine can utilize. For a variety whose bunches average one pound, and produce two bunches on each shoot, 12 bunches would give 24 pounds, or about seven tons to the acre.

Those canes should be chosen which will have the spurs in the most suitable position for forming arms; and arms should be chosen which will distribute the canes most evenly

avoiding those which cross, or point downward. Choose only those canes which run in the direction of the trellis.

Pruning After the Third Winter,- At this time it is necessary for the pruner to be able to distinguish between fruit, and sterile wood. Fruit spurs must be left to produce the crop to be expected from the size and vigor of the vine; and it may be necessary to leave sterile spurs to permit increase of the number of fruit spurs the following year. Finally, when the full complement of arms has been developed, sterile wood must be left to supply new arms to replace those which have become too long, or otherwise defective. If an arm is long, and at the same time weak, it should be pruned to extra short spurs. This will tend to force water sprouts to start from the older wood near the base of the arm..

Fan Shaped Vines,- At the third winter's pruning the formation of the head takes place, and the pruner determines whether the vine shall be vase form, or fan shaped. The third winter the vines should be pruned to two spurs; more vigorous vines should be given more buds, and not more spurs. With extremely vigorous vines, one fruit cane may be left at this time. The wire of the trellis should also be put on now if it has not already been done. Since the form of the vine is determined by the renewal spurs, special attention should be given to their position, and they should be chosen as nearly as possible in the plane of the trellis.

Double Headed Vines,- This is an attempt to raise the arms in two stages, one above the other so as to make a two

crowned vine. This system is open to the criticism that it can not be maintained permanently , for the lower head becomes weak, and the arms fail to produce wood.

Vertical and Bowed Canes,- This method is not satisfactory in most cases, for the fruit has a tendency to start from high up, near the middle of the vine, and the canes are too short for the best results; while the canes that start from low down are in most cases suckers, and are, therefore, of little value as fruit producers. Where the canes are bowed in, this method of pruning will work very well in the cooler regions, but not where the vines make a very vigorous growth.

Vertical Cordons,- Here the trunk is three to four feet long instead of one to two. This method requires a longer and more vigorous cane, and it may take a year longer to develop it. The vine is then formed as for the Second winter pruning, but is longer. The following year, when the vine is pruned, spurs are left at intervals along the trunk. Each of the spurs is the commencement of an arm, and also a fruit spur. It is very difficult to keep the lower part of the vine growing as it becomes older, and instead of a cordon, there is simply an inconveniently high headed vine. The double vertical cordon has no advantages over the single, is more troublesome and costly to prune, and the fruit is more difficult to gather without injury.

Horizontal Cordons,- Here the same means as was described in the previous paragraph, is used to produce a strong cane. When a well ripened cane is obtained, it is tied to

a wire stretched 15 to 24 inches above the ground, horizontally along the row. The rows should be 12 to 14 feet apart, and the vines 6 to 8 feet apart in the row. The trunk should reach the full 8 feet, and the canes should reach at least half that distance when layed down, the remaining length being gained by a cane from this main trunk. Only those shoots should be allowed to develop that are conveniently situated for permanent arms. In short pruned vines, the arms should be developed every 8 to 10 feet, while in the long pruned vines, they should be every 12 to 20 feet. The longer and stronger canes should be pinched back to force the weaker ones. At the end of the season these canes are pruned back to 2 or 3 buds. The vines should be well suckered the following year, care being taken to remove shoots that start from the lower side. At this time, which is either the fourth or fifth year after the vines have been planted, the final style of pruning may be applied. The vines are pruned either short, half-long, or long.

Renovation of Imperfect or Misshapened Vines,- As the vines become older, it is increasingly difficult to overcome a defect of formation. The disadvantage of the low head may be partly avoided by lengthening the arms, and giving them a more vertical direction. An ill formed head may be improved by removing badly formed arms, and developing new ones properly placed. In misshapened vines, a new cane can be developed from the ground, and the main trunk removed. This is open to the objection that it leaves a large wound that never heals, and permits the entrance of wood rot fungi.

They last as long as the old decayed vines, and will be more fruitful, and easier to handle properly. The change can be made without the loss of a crop, as occurs in top grafting.

Choice of Systems,- A variety which bears only on the upper buds, must be pruned long. In general, grafted vines require longer pruning than do ungrafted ones. Vines made vigorous by proper soil , moisture, and cultivation, require longer pruning than do weaker ones of the same variety.

CHAPTER VIII.

Systems of Vine Pruning

Before one begins to prune grape vines, he should consider how he wants the vine to look when he is through pruning, and in order to have the proper mental picture he must know what the objects of pruning are.

The objects of pruning are; to facilitate culture and gathering ; to increase the average yield; and to improve the quality of the fruit. Methods of pruning which increase the vegetative vigor of the vine, tend to increase its bearing quality, while anything which tends to diminish vegetative vigor, increases fruitfulness.

Since the vine tends to force out terminal buds, and to spend most of its energy on the shoots farthest from the trunk; this tendency must be controlled by removal of the terminal buds. The nearer the shoot approaches the vertical the more vigorous it will be. Usually, the fewer the shoots, the larger will be the bunches.

Other conditions being equal, an excess of foliage is accompanied by a small amount of fruit and an excess of fruit by a small amount of foliage.

Shoots coming from one year old wood, and growing out of two year old wood, are alone to be depended upon for fruit. Other shoots are usually sterile.

Bending, twisting, or otherwise injuring the tissues

of the vine or its branches , tends to diminish its vegetative vigor; and , therefore, unless excessive, to increase its fertility.

Water sprouts and suckers do not ordinarily produce fruit bearing shoots. It is on the laterals, and secondary laterals, that the so called second and third crops are born.

Pruning for Wood and for Fruit,- One of the first aims of pruning is to maintain an equilibrium between vegetative vigor and fertility. A vine which has become enfeebled by overbearing should be pruned to wood, which means that only a small number of buds should be left. The second year more wood may be left, and the crop increased without detriment to the vine.

On the other hand, a vine which "goes to wood" must be pruned for fruit. This is done by selecting the medium sized canes with well formed eyes. If a cane is cut through a node, an effectual barrier is left which is a protection against decay organisms. If a spur projects too far from the vine, the cut should be made as near vertical as possible. In a cane which is to be removed completely the cut should be made thru the base of the cane, at the enlarged part.

Short and Long Pruning,- In all kinds of pruning most of the canes are removed entirely . In short pruning, the remainder are cut back to one, two, or three eyes, while the number of spurs is regulated by the vigor of the vine. This mode of pruning can only be used where the eyes near the base of the cane are fruitful.

In half-long pruning certain spurs are left with four to six buds according to the length of the internodes. These will bear more fruit than short pruned vines, because 1. There will be more fruit bearing shoots. 2. The upper eyes are more fruitful than the lower. 3. Where a large number of eyes are being supplied with sap from the same cane, each shoot will be less vigorous, therefore, more fruitful. Since the buds close to the vine are fewer it is well to leave a few short shoots to produce the canes for the following year, and to remove the long canes entirely.

In long pruning, several canes are left 2 or 3 feet long. Since the tendency of the vine is to expend its vigor in producing the terminal growth, it is necessary to twist and bend these canes somewhat, so that by causing a certain amount of injury, the flow of sap toward the ends of the canes is checked. It further diminishes the vigor of the canes, and thus causes fruitfulness. The proper application of the principle is to injure tissues only of those parts of the plant which it is intended to remove the next year.

The Systems of Pruning Are,-

A. Vines pruned to a head with short arms.

1. With spurs 2 or 3 eyes long.

2. With wood spurs of 1 or 2, and fruit spurs of 6 or 8 eyes. (half long pruning).

3. With wood spurs of 1 or 2 eyes, and long fruit canes.

B. Vines with a long horizontal branch, or continuous with the trunk.

1. Spurs 2 or 3 eyes long.

2. With wood spurs 2 or 3 eyes long, and fruit spurs of 6 or 8 eyes.

3. Long pruning.

The system of pruning used depends upon; the vigor of the vine; position of the fruit buds; and the size of the individual bunches.

Type I. This is the ordinary short pruning practiced in 90% of the vineyards of California, and is suitable to a vine of small growth and good fruiting habits. The objection to the system is that it favors rotting, because of the massing of the bunches, and exposes bunches to different degrees of light and heat.

The vine must be made to assume the goblet form, and with some upright growers it will be found necessary to choose spurs near the horizontal. If the vine appears as tho it were going to wood, two spurs may be left on some or all of the canes. In this case the upper spur should be cut above the third eye, and the lower one above the first or second.

Type II. Vines which require more wood than can be given in short pruning, may be pruned so as to allow a few canes to grow having 4 to 5 eyes. Sometimes each of the arms are tied together, but it is better to attach them to the stake, and bend them at the base a little, in order to retard the flow of sap. It is very necessary to have strong spurs of one eye to provide wood for the following year. The fruit wood of the year must be removed, and the canes cut long. If no fruit wood was formed, it shows that too much wood was

left the first year, and short pruning must be resorted to.

Type III. In this form of pruning a few long canes are left, and a few good strong shoots of one or two eyes, to produce the wood for the following year. These canes should not be tied straight up to a stake, because they will have a tendency to produce wood only. When two canes are tied it may be done by bending them in a circle, and tying the ends near the head of the vine, and again at the top of the cane. Another way is to stretch a wire 15 or 20 inches from the ground, and attach the fruiting canes along this. The wood canes may be attached to the stakes. This form of training is desirable for varieties of small growth, which bear small bunches near the ends of the canes, but there is danger of sunburn. In order to maintain a well balanced, long pruned vine, and keep it under control, there should only be about as many arms as long canes.

It has been found that in many soils, many vines, especially table varieties, do not produce to their maximum power under the systems described, and for this reason the vines have been allowed to grow in a horizontal direction for three or four feet, thus giving a larger fruiting surface. As soon as a good strong cane is produced, it should be trained along a wire, and tied up to the stake. Two main branches from the same vine are not desirable because it is difficult to maintain a balance between them. The cane that is developed should be trained in the direction of the prevailing wind. When the cordon, or main body of the

vine is formed, it may be pruned in any of the three ways described .

Summer Pruning,- This form of pruning is most harmful under warm dry conditions, and very essential where the weather is cool and damp. The principal kinds of green pruning are,- pinching, suckering and sprouting, topping, and removal of leaves.

Pinching is the removal of the extreme tip of the shoot for about $\frac{1}{2}$ an inch. The result of this operation is to concentrate the sap in the leaves and blossoms, and force out the dormant buds. It can be used only on fruiting shoots, and not on those intended for wood the following year.

, Suckering is the removal of shoots that have originated below, or on the surface of the ground. Presence of suckers indicates that the vines have been pruned too closely, careless suckering in former years, frost, or injury to the vine

In connection with the subject of suckering, it is advisable to see that this part of the vineyard work is attended to early in the season. As soon as the suckers have grown two or three inches, it is advisable to rub them from the base of the vine with the hand.

Sprouting is the removal of water sprouts , or sterile shoots from the vine. This is usually not necessary except in the case of Muscat of Alexandria vines. Water sprouts come from the dormant buds on the old wood, and indicate that a too limited number of fruit spurs has been left on the vine. If not too numerous they are a positive advan-

tage, since they are just so much increase to the feeding area of the green leaves.

Topping,- Early topping is not advisable since it induces a vigorous growth of laterals that make too dense a shade, and it may even force the main eye to sprout, thus injuring the wood for the next year. The topping should be so timed, that while a further lengthening of the main shoot is prevented, no excessive sprouting of new laterals is produced.

The beneficial results that accrue from topping, do not seem to be commensurate with the cost of the operation; and unless one is careful to see that the workmen do not remove too much of the foliage in this operation, the fruit is likely to sunburn.

Removal of leaves is done after the season's growth has taken place, and while the fruit is ripening. Only the leaves from the center of the vine should be removed, and this should be done gradually so as to prevent sunburn. This operation results in better fruit, but it is not likely that it can be practiced on a commercial vineyard with profit, especially if the vine grower is hiring all of this work done.

CHAPTER IX.

Cultivation in California.

It was demonstrated early in California experience that "clean culture" is the proper treatment for both trees and vines, during the growing season at least. It may be held to be the essential of successful growth of vines in most soils and situations in California, and the several advantages of clean culture are intensified under these conditions.

Chief of these advantages is the maintenance of the soil in a condition favoring root growth, and the main feature of this condition, is the retention of the moisture, tho regulation of the temperature of the soil is also involved. In irrigated districts of excessive heat and dry air, the policy of clean culture should be the rule.

Retention of Moisture by Cultivation,- When a soil is broken up by cultivation, capillarity is temporarily destroyed thru the disturbed layer because the particles are so separated that the connection of the minute inter spaces no longer exists. Where the cultivation has left only clods, the air has access to the firm soil beneath that in which the capillary condition still exists, and evaporation proceeds in the same way, tho in a somewhat less degree, as if there had been no cultivation. It becomes evident, then, that the pulverization of the disturbed layer must be so

complete that the particles are separated and capillarity destroyed. This is accomplished by the fine loose earth which acts as a mulch. When such a condition is attained, only that moisture in the upper surface which comes in immediate contact with the air is evaporated, and the balance is retained for the use of the plants. Plants grown in a well cultivated soil, have the water in the lower soil held for their use, and as fast as they use it, the supply is replaced by the firm soil from below.

Figures to show the amount of water retained in cultivated and non cultivated soils are as follows,-

* Depth of soil	Cultivated		Uncultivated	
	per-cent.	Tons H_2O . per acre	per-cent.	Tons H_2O . per acre
First foot	6.4	128	4.3	86
Second foot	5.8	116	4.4	88
Third foot	6.4	128	3.9	78
Fourth foot	6.5	130	5.1	102
Fifth foot	6.7	134	3.4	68
Sixth foot	<u>6.6</u>	<u>120</u>	<u>4.5</u>	<u>90</u>
Totals for 6 ft.	6.3	756	4.2	512

This table shows that a gain of nearly 50% was made by cultivation.

Necessity of adequate Cultivation,- The depth of cultivation, or the thickness of the dust mulch must be sufficient to prevent the access of dry air to the firm soil below. In the East where the air is moist, a thin mulch may do but in the West where the air is dry for a long period

* Wickson.- California Fruits. p. 143.

of time, there must be a deep tilth. The cultivation should go to a depth of 4 to 6 inches ordinarily, and then the result will be accomplished if it is done frequently to prevent the refirming of the soil by atmospheric pressure, or by the rise of moisture from below.

Loss of Moisture by Weed Growth,- One of the most active agencies for the exhaustion of moisture from the soil is the growth of weeds. Altho under the cover of weeds moisture may appear even at the surface and convey the impression of moisture saving, the fact is, that the moisture in the lower layers of the soil is reduced. For this reason all weeds must be eliminated during the dry season.

Moisture Storage in the Soil,- The moisture supply is equalized by the storage capacity of the soil, and a surplus from the rainfall of one year is held over to supply the lack of the next. The well cultivated surface has the advantage that it will catch more water than the hard uncultivated fields where the heavy rainfalls flow off to the lower levels.

Growing Crops Between the Vines,- The general rule is that there should be no crops grown between either trees or vines. Interculture in the vineyard may be allowed where the soil is deep, moist, and rich. Where irrigation is available much more can be done in this direction, than where the grower is dependent upon the natural supply of water.

There is much difference in crops and the amount of injury that they do. Corn, beans, potatoes, beets, carrots,

squash, and onions, are crops that are least inurious to vines because of their requirements and the fact that they are constantly cultivated. Care should be taken even in this case not to plant too close to the vines.

All inter-cropping is a loan made by the trees or vines to the orchardist. Sooner or later, however, the main crop will need restitution to the soil of the plant food removed by inter-culture. This may be done by adding fertilizers, but as a rule the vines should have the full strength of the land, as well as all the help which can be given them in the shape of thorough cultivation.

Methods of Cultivation,- In general terms, the main objects of cultivation are two: Winter cultivation for moisture reception, and summer cultivation for moisture retention.

Whenever winter plowing can be done without too great danger of soil washing, it affords the best means of admitting water to the lower levels of a deep soil. Deep penetration of winter rains should be in all safe ways promoted, but soil washing and drainage that carries with it much sediment, should be avoided.

To serve these purposes there are two main divisions of practice in the State. First: Winter plowing followed by frequent use of cultivator and pulverizer in the summer. Second: Use of cultivator at intervals both winter and summer, followed, if needed, by pulverizer in the summer.

Plowing,- Some plow toward spring, and if there is much

growth of weeds, a looped chain is run from the plow to the end of the evener, to aid in drawing under the tall growth. Where but one plowing is done, the soil is usually thrown away from the plants, and afterwards is leveled back by harrowing or cultivating. Care should be taken to see that the soil is returned to the roots, for injury is sometimes done by bringing the roots too near to the surface of the ground, which is soon afterwards intensely heated by the sun.

It is probably better practice to plow earlier and turn under the green growth before it gets too rank. Where early plowing is practiced, it is usual to plow again when the second growth of weeds reaches the proper state in the spring. In the first plowing the soil is usually thrown away from the vines, and returned to them at the second plowing. This order is sometimes reversed in situations where rainfall is heavy, for the dead furrow between the rows acts as a surface drain. In all modes of plowing, however, it is desirable that before the summer heat comes, the surface be leveled as completely as possible.

Too much stress can not be laid upon the importance of plowing when the soil is in good condition, and not otherwise. This is particularly so of the clay soils, because they are sure to break up into hard clods if worked when they are too wet. This condition is well illustrated in the case of adobe, for to work it when it is too wet results in lumps that are unmanageable, while it can not be worked when dry.

Breaking up Hardpan or Plow-sole,- When cultivation is

carried on at a uniform depth during the summer, a layer of impervious earth is formed just below this. Such plow-sole may be broken up by plowing more deeply so as to get under this. Such a measure will allow the free passage of water downward.

The old method of contour plowing to prevent washing on hill-sides does not seem to be favorable because the water collects in hollows , and if it breaks away, it carries considerable sediment with it.

A better way to prevent washing, is to plow furrows 7 or 8 feet apart straight down the hill in the direction of the deepest descent. This distributes the rain-fall, and does not allow it to collect in any one place. A few furrows may be plowed in this way, and the weeds allowed to grow to hold the soil together. Soil conditions, and local rain-fall will largely determine the method to use.

The best plow to use will depend upon the local conditions, the distance apart of the rows, and the size of the vineyard. Heavy soils will pull a team too hard if a large plow, or a gang plow is used, while in light sandy soils, a light gang plow may be used profitably.

The size of the plow should be adapted to the width of the rows so that two complete rounds, or three rounds , will be sufficient to till the center of the row; leaving only a few inches of soil close to the vine that must be turned with a single plow. Some of the small growers use a light single plow, or a gang with two eight or two nine inch

shares. The larger vineyards frequently use the gang with three eight inch shares, to which they hitch four animals. This enables the driver to keep his team going all day.

The tools used to cultivate the vineyard have been open to considerable criticism because of the injury caused to the vines. Injury to the roots by too deep plowing, barking of the vines, and breaking spurs and arms by parts of the harness, and especially by wide single trees, have been among the criticisms made. Much of this difficulty has been removed. Specially constructed vineyard plows that will work on either side of the line of draft have aided greatly in plowing. Narrower single and double trees, flat hames, and the avoidance of rings and hooks on the harness has helped to prevent this injury..

Summer Treatment,- Where the vineyard is plowed twice during the winter, the land should remain after the first plowing, as the plow leaves it. If but one plowing is done when the rains are over, the vineyard should be well harrowed, for the surface should be leveled as much as possible.

In heavy soils, the object is to pulverize the surface soil without compacting it; while in light sandy soils, heavier tools that will firm the soil are desirable. For this purpose a long toothed harrow will be effective. Rolling is another good practice. When the soil has been worked down after plowing, the cultivator is relied upon to kill the weeds, break up the crust which may form after the spring rains or irrigation, and to prevent the compacting of the surface of the soil.

Cultivation Without Plowing,- This has been the practice in some parts of the State, for some vineyardists have never used the plow, and believe in the value of continued and deep cultivation throught the year. Chisel- toothed cultivators which will stir the soil to a depth of eight inches are obtainable, and so, it is seen that the soil may be stirred deeply. The disadvantages of this system, however, have lead many growers to abandon it. In heavier soils that shallow cultivation is apt to render too compact, plowing is necessary to permit aeration, and penetration of moisture, which otherwise would be largely lost by surface run-off. The continued cultivation seems to decrease the humus in the soil, and the water holding capacity. Either the fall or spring plowing, or both, followed by summer cultivation, is the most rational and satisfactory practice; tho there are local conditions under which different procedure is preferable.

In the central part of the San Joaquin Valley, plowing is usually begun in January or February. The vineyards are plowed twice, once each way, in vase formed vines, and cultivation is continued until the new shoots have grown to a length of 15 inches to three feet.

Summer Cultivation,- The essential point in summer cultivation is to pulverize the soil. The finer the pulverization, the shallower can be the surface layer; and this is probably why the plow is so universally used.

Sometimes a "rubber" made of planks is used to reduce any small clods in the vineyard. Care must be exercised to see

that the soil is not left in a smooth , firm , condition, that will allow rapid evaporation to take place. Even tho no rain falls, and irrigation is not practiced, it is necessary to continue cultivation, for the soil has a tendency to become compacted, and this allows evaporation to take place.

The only weeds that cause much trouble are Morning-glories. These are best controlled by going over the vineyard as often as once a week with a weed cutter. The vital point is a blade of sheet steel, very sharp, and rigged to run just under the surface.

Mulching,- The mulch is used to a limited extent particularly in vineyards situated on hill-sides where cultivation is difficult. Partly rotted straw, damaged hay, coarse manure, corn husks, corn stalks, vine prunings, and leaves, are all used as a mulch. In many cases satisfactory results have been obtained, but the chance of fire in such a dry climate is evident.

CHAPTER X.

Irrigation of the Grape.

If irrigation is to be practiced, the following facts must be taken into consideration; the kind and depth of soil upon which vines are to be grown; the amount of rainfall; and the lay of the land that one proposes to irrigate.

In order to judge whether a grower shall practice irrigation in any particular situation, he should take into account the present condition of his vineyard. If he harvests a good crop of fruit of large size, and if the vineyard is in a thrifty, healthy, condition, there should be no necessity for irrigation. But if his vineyard lacks vigor, and the fruit is of small size, even after being properly thinned, he will do well to irrigate his land where it is economically possible.

There have been some objections made against irrigation that have prejudiced many people against it. Some of their claims are, that irrigated nursery stock makes excessive growth, and does not do well when planted in the vineyard. Furthermore, that irrigated fruits lack aroma, do not ship well, and are inferior in drying qualities. The bases for these claims has been the results of over irrigation. Some growers have believed that if a little water did some good, a lot of water would do more, and as a result have given

the vineyard too much. This practice has resulted in the production of fruit that was flat, insipid, and unduly inflated by the excess of water.

The question of just how much water to apply is one that will have to be answered for each locality independantly, and by the grower himself. The character of the soil and sub-soil, the amount of rainfall during the year, and the kind of cultivation that the soil receives, are all points that will influence the amount of water required. In general, though, sufficient water should be applied to produce thrifty and adequate wood growth, strong, good colored foliage, and an abundance of good sized, well matured fruit, that is not watery.

. Relation of Rainfall to Irrigation,- The quantity of irrigation water that should be applied to the land in a given locality will not only depend upon the amount of rainfall, but also upon the condition and retentiveness of the soil. The soil may be incapable either of receiving the water that falls, or it may not be retentive enough to hold sufficient water to carry the plants over the dry season. For this reason we can not say that because a certain region receives more water than another, that the former will produce larger crops, or better fruit than the latter. Generally speaking, however, in almost any part of the State, twenty inches of rain is sufficient to grow a crop, and if that amount is not forth-coming in the form of rain, it will usually have to be provided by irrigation. As a general rule, it may be stated that ten inches of water applied to an

average soil during the growing season, and followed by thorough cultivation will be sufficient to produce a crop of fruit of the right kind.

In some parts of the State where twenty inches of rain fall annually the soil is of such a nature that irrigation must be resorted to ; for the vineyard may be located on a thin layer of soil underlaid by rock or hardpan; or the slope may be such that the water drains off rapidly. In these situations, even an abundance of rainfall must be supplemented by irrigation.

In the San Joaquin Valley near Visalia, there are soils some two feet above river bottom that need no irrigation even though the annual rainfall is only about seven inches. Further north, where the rainfall is eleven inches irrigation is practiced freely. In the center of the Valley, around Fresno, there are vineyards which require no irrigation, because of the high level of the water table. Here the water table may rise to within six or seven feet of the surface, and the deep penetration of the roots enables the vines to thrive. In such places, however, it has been found very advantageous to provide means of applying water to the land in times of drought.

Only about eight miles east of Fresno there is a slight rise in the level of the land, and a lowering of the water table, so that from this point east, the growers irrigate once or twice during the season.

Relation of Tillage to Irrigation,- The question of tillage has been taken up in a chapter devoted to that

subject; and an attempt made to show the beneficial effects of thorough cultivation following irrigation. After the vineyard has been irrigated the soil will be thoroughly compacted, there will be numerous capillary tubes extending to the surface, and evaporation will take place very rapidly under the hot sun, and the dry conditions of summer. For this reason cultivation should follow irrigation as quickly as possible, and the soil should not only be well stirred, but should be reduced to the fine deep mulch which has proved to be so effective in preventing surface evaporation. In light sandy soils, cultivation may sometimes be started the day following irrigation, but in the heavier soils it is advisable to wait several days, or until the soil may be stirred without rendering it cloddy. The vineyardist should make special effort to cultivate just as soon after irrigation, as the condition of the soil will permit.

When to Irrigate,- In some situations where the soil is deep, winter irrigation, followed by deep plowing and diligent cultivation, to keep sufficient moisture in the soil for the crop the following year, is a good policy. In this way, the small amount of water that falls during the growing season can be utilized to the best advantage. In some situations, however, particularly on hill-sides, and on land underlaid with hardpan, no amount of winter irrigation will be sufficient to tide the crop over the hot dry summer, for it is impossible to conserve sufficient water in such a thin layer of soil.

The advisability of summer irrigation depends upon the

distribution of summer rains, the quantity of water available, and the possibility of water available for irrigation during the summer. In some situations the soil may have dried out for several feet, here it will be found advisable to let the water soak thru the dry soil so that capillarity will be reestablished with the moisture below.

Just when summer irrigation shall begin will depend upon the locality. In some parts of the State even the early fruits must be irrigated, while in others, only the later fruits need it. Supplementing the rainfall by winter irrigation may be sufficient to mature the fruit, but not the wood for the following summer's growth; and so, in each locality the needs of the vines must be studied, and that amount of water applied which will produce the best growth of vine and fruit.

The need of thorough cultivation after irrigation has already been taken up, but in some situations where there is an abundance of water available for irrigation, the tendency among some growers has been to use too much water and to cultivate too little. Such a practice has a bad effect upon the soil, because it does not permit the free circulation of the air, and prevents that mellow condition which is favorable for the best growth of plant roots. Furthermore, excessive irrigation often causes the berries to crack, and may cause a drooping of the foliage, and shriveling of the branches. It is also believed to be responsible for the injuries caused by mildew.

METHODS OF IRRIGATION.

The arrangement of the main ditches, and the permanent structures should come first on the ranch. Dirt ditches were formerly used to convey water, but now wood and concrete flumes, and concrete lined ditches have been substituted in large part for the dirt ditches; particularly in southern California where the water supply is limited. Generally speaking, the large ditches are put in either by a canal and irrigation company, the Government, or co-operatively, by the growers. From these main ditches, the water is conducted in smaller ditches thru the vineyard, and from these onto the land.

The Flooding Method,- Flooding is the application of water over the entire surface of the land. As a means of distributing the water, small ditches and laterals are located along the best routes. These form the network of channels which cut up the field in small strips which may be 50 to 100 feet in width. The ditches are constructed both along the steepest slope, and along grade lines, and extend from the head ditch in more or less curved lines across the field. A suitable fall is $\frac{1}{2}$ to $\frac{3}{4}$ inch to the rod.

This method is only employed on lands where winter irrigation is used to supplement rainfall; when the latter is occasionally deficient. Summer flooding is scarcely ever used except by those who are somewhat backward in their agricultural methods.

It may be said as a general rule then, that the free flooding method is not used in the irrigation of grape vines.

The Check System,- This method is the conversion of a field into a number of checks or compartments with low flat levees, and a bordering supply ditch. These checks are known as the rectangular and the contour. The boundaries of the former are straight , forming rectangles usually much longer in the direction of the least slope; while the boundaries of the latter conform to the natural slope of the land. The ground is leveled so that the slope will not be too great. The essential feature in checking being to arrange each tier of checks in such a way that each can be flooded from a supply ditch.

The check system is used principally where water percolation is rapid. Because of the larger head of water required, the difficulty of handling, the more working in mud and water, and the greater difficulty of cultivation, there is a tendency for the farmers to use the furrow system wherever possible.

The larger levees are only used where the land is flat, and often with grain growing. Usually the levees are smaller, and are constructed by plowing a double furrow so as to make a temporary ridge which is afterwards cultivated down.

The Basin System,- This method is one in which only a few vines, usually from 4 to 12, are inclosed by a furrow. This system is not generally used since the furrow system is easier, but in some conditions there is an advantage in using the basin system. Some of the conditions under which it is an advantage are the following. 1. It is well suited to the

irrigation of hill-sides that are too steep for other means of irrigation. 2 A very small stream of water may be utilized by allowing it to flow for a long time in each basin. 3. The expense of wider application of water, and the cultivation of the larger area is curtailed.

The Furrow System,- Irrigation by means of furrows is the prevailing method of applying water to vineyards. The chief advantage lies in the fact that vines can be given an adequate supply of water without running water around the vines, for where summer irrigation is practiced it is impossible to cultivate very close to the vines without injuring the spurs and young shoots. Usually the furrows are run between alternate rows of vines, altho in some cases they may be plowed between each row. When clay loam soil is irrigated it is easier to run water in every row of vines because of the slower penetration of the water into the soil.

One of the tests used to determine whether sufficient water has been applied, where furrows are run in alternate rows, is to dig down between the two furrows. If the water from each of the furrows does not meet at this point at a sufficient depth to supply the roots with moisture, it shows that a proper amount of moisture has not yet been applied.

The practice in most of the vineyards around Fresno, California is as follows; Water is conducted along the high ground of the vineyard in large ditches that are plowed out, and then banked up by using a V. From these ditches the furrows along the vineyard rows run at right-angles, usually

not more than 200 yards. The water is run into the lateral ditches from the main irrigation ditch, and the rows at the end of the ditch are frequently irrigated first, altho the reverse order may be used. A metal dam or "Tapoon" is set in the latter ditch so as to raise the water high enough to flow into the furrows. As soon as the lower end of the furrow is filled with water, a dam of earth is made about every three or four vines, depending upon the slope, and the furrow is filled with water, which is held by these small dams until the irrigator has worked back to the lateral ditch again. The side of the lateral ditch is banked up with earth and the water conducted to the next furrow. When the furrows have been irrigated as far as the first "Tapoon", it is removed, and the water allowed to flow down to the next one. This is continued until the end of the vineyard is reached.

If the ground has but a slight fall, and the ditches and furrows are made beforehand, it is possible to use a large head of water, and a big force of men. Under an irrigation system where each grower is allowed a certain fixed time during which period he will be allowed to use the full head of water in the ditch, it is essential that everything be in readiness so that a thorough irrigation may be given in the time allowed.

CHAPTER XI.

Fertilizers for the Vineyard

At one time the popular belief was that California soils did not need fertilization; but at the present time, growers, especially in the Citrus fruit districts, are beginning to find that such is not the case. In some sections the need of fertilizers is clearly seen, and generous applications are being made each year.

On the other hand, the grower should not conclude that all soils need fertilizers, and if the growth of the plants is such as to indicate health and vigor, heavy fertilization is to be avoided.

When a vine that has been properly pruned and cultivated is unable to mature a good crop of fruit, it may be due either to a lack of plant food, or water. In examining the soils for moisture one should dig deeply, for there have been cases of moisture near the surface, and drought below.

The question of just what fertilizers to apply to the vine is rather hard to answer, and must be decided for each particular case. Analysis of the soil to determine the available plant food is of utmost importance, and careful observation by the grower when fertilizers are used is essential. When fertilizers are used they may produce results that are misleading, and so it is best to use a number of check plots.

Based upon the characteristics of California soils,

Doctor Hilgard advises that any large scale fertilization begin with phosphates and nitrogen, and then, if this is not satisfactory, follow by applying potash also; this being the order in which these substances are likely to become deficient in most California soils.

Available Fertilizers,- Phosphorous: Bones may be collected around the vineyard, or may be gathered from the butcher shops in an adjacent town. These may be put into a well kept(moistened) manure pile where they will decay and enrich the manure. Bones packed in moist wood ashes to which a little quick lime has been added, will in a few months be reduced to a fine mush.

Potash,- Plants are beginning to need potash in certain parts of the State, and where there is no deficiency often they will do better where the potash is made more readily available. It has been found by investigation, that a bushel of ordinary wood ashes contains $4\frac{1}{2}$ pounds of potash, and 1 pound of phosphorous. Hence there is enough potash and phosphorous to make a bushel of ashes worth twenty or twenty-five cents. Ashes should be kept dry or applied at once, for ashes that have been leached by rains are valueless.

Nitrogen,- Nitrogen for the vineyard is often necessary, for, due to the continued cultivation required to conserve moisture, there is little opportunity for the growth of legumes which could be turned under and utilized by the plants. Barnyard manure is perhaps the best general manure to use, altho cover crops may be applied to advantage. Of

commercial forms of nitrogen, tankage, dried blood, and Chili saltpeter are fertilizers that render the nitrogen very quickly available. From 150 to 200 pounds per acre is the usual application.

Lime,- Applications of 800 to 1000 pounds of burned lime stone as a top dressing on a heavy clay soil unlocks large amounts of organic matter and plant food; and makes the soil more friable. Lime is very good to use after barn yard manure has been applied for several years, or on rich alluvial soils where there is excessive growth of wood and leaf. Light soils are usually not helped a great deal by the use of lime.

Gypsum is valuable to set free other plant foods such as potash, magnesia, and ammonia, which may be in insoluble form. The fact that gypsum is a soil stimulant rather than a soil food, is a thing that should be kept in mind. For this reason it does not seem advisable to recommend the use of gypsum for California soils.

Barn-Yard Manure,- The heavy coarse manure containing considerable straw is not to be recommended as a fertilizer for light soils, because it does not rot quickly under such conditions, and it loosens the soil thus permitting the rapid evaporation of moisture.

Manure should be gathered up and put on the land before the winter rains, and should then be plowed or cultivated into the soil. The manure that falls during the winter should be collected in a pile, and all kinds of green stuff that will decay should be added. Fresh horse manure may be added

to hasten the decomposition. The weed seeds will not have enough vitality to germinate, and this compost, if protected from the heavy rains so as to prevent leaching, will form a valuable fertilizer.

Where no composition is undertaken the manure should be applied during the rainy-season directly to the land if wagons can be driven over it. During the dry season the manure can be tramped into dust by the stock in the corral, for no losses will occur by fermentation. Near the end of the dry season the corral should be scraped and all the material spread on the land.

Sheep manure is usually richer and quicker, though not so lasting in its effects as the stable manure. Analysis has shown that this material has a value of about \$14.00 per ton when ground and placed upon the market.

Other Products,- Soap suds, peelings, fruit refuse, and ashes from burned vine prunings are all valuable as fertilizers. Winery refuse may also be used to advantage where they do not make the soil too acid.

Application of Fertilizers,- Manures when applied should be in a finely divided condition. Ground bone should be plowed in as deeply as possible without injuring the roots of the vines. Very soluble chemical fertilizers will produce immediate results, and can be most economically used on light and easily permeable soils. Spring applications of fertilizers are best made by spreading it on the vegetation which is plowed under at that time.

Manure With Irrigation Water,- Some growers have advocated the use of fertilizers with the irrigation water. There are several reasons why this method of applying fertilizers should prove advantageous. The fertilizers so applied would be broken into fine particles, they would be distributed evenly over the surface of the ground if the vineyard was flooded; and they would penetrate deeply into the soil, thus coming in contact more quickly with the roots of the plant.

One grower shovels sheep manure into the irrigation ditches at the rate of 1 ton, to $1\frac{1}{4}$ tons per acre. In the fall a box is set into the ground at the head of the irrigation ditch, about six inches below the top of the water, and a barrel of lime is placed in the box. As the water flows into the ditch it takes up the lime and becomes milky white. The weeds that have grown up during the winter, lime, potash, and other fertilizers, are all plowed under in the spring.

Fertilizing Value of Irrigation Water,- The irrigation water that is used on a vineyard may have a good or a bad effect, depending upon the amount of food material or salts that it contains. Some of these waters have been known to carry as much as a half grain of potash per gallon of water; others carry lime, iron, salts, etc., all of which are valuable as food for plants when they occur in available form. On the other hand, such waters may contain a large amount of alkali, and since this obnoxious substance has a tendency

to accumulate on the surface of the ground, and kill the roots, irrigation water may be injurious to the land over which it flows.

Cover Crops for the Vineyard,- Any green crop that is plowed under is known as a cover crop. Such a crop makes the soil looser, adds plant food and humus, and may add nitrogen to the soil. This is particularly so in the case of the legume. Cover crops are further desirable because they make it possible to get results from the cheaper forms of phosphate, such as Thomas slag. They greatly improve the mechanical character of the soil, as well as putting the soil in a condition to retain a larger amount of moisture. They are a means of overcoming hard-pan and plow-sole, and also help to prevent soil washing in winter.

Altho the custom of clean culture has been advocated by many of the grape growers, some are beginning to realize the advantage of planting a leguminous crop of cow peas or alfalfa between the rows, where they have had sufficient water to enable them to do this. The practice of planting legumes in the summer is out of the question because it interferes with summer cultivation, and because of the large quantities of water extracted from the soil. What is needed is a rapid growing legume that can be planted in the fall, will grow thru the winter, and can be plowed under in the spring. Just what crop is best for this purpose will depend upon local conditions, but "burr clover", "Canadian field pea", winter vetch, hairy vetch, and fenugreek, are all coming into quite wide use in different parts of the State.

CHAPTER XII.

Harvesting the Grape.

Of all the seasons in grape growing, that of the harvest is most important. It is the one in which the grower has the most responsibility, and is a time when a slight delay or oversight in some particular of the work is likely to result in great loss. At this time there is a large quantity of fruit ripening, and in order that the picking may be kept well in hand it is necessary that everything be in readiness to begin the harvest season. Unless the grower had made provision for pickers and teams, he may find them hard to secure. On large plantations, written contracts with pickers should be made, wagons and teams secured, and picking boxes and trays on hand, as far as possible before the actual season begins.

Preparation for Harvesting.

Trays and Boxes.— Each grower should have a sufficient number of picking boxes and trays. The number and size of the boxes will depend upon the size of the vineyard and the kind of grapes grown, and upon the distance that the grapes have to be hauled.

For wine grapes a box holding approximately forty or fifty pounds of green fruit is used. These are usually made of one fourth inch pine boards with seven eighths inch pieces for ends. In general the forty pound picking box seems to have the preference, both because it is lighter, and because

it does not break up as easily as the larger fifty pound boxes. These boxes are bought in the "knock down" and nailed together on the ranch during leisure time.

It is advisable to go over the boxes during the winter months and repair those that are broken, or have become loose. If this is done in the fall, and boxes are stacked in the open many of them are apt to become loose through weathering, but if they are stacked in a dry place under a shed, or covered with a heavy canvas or tarpaulin, they will remain in good condition.

For table grapes there is a special box built that is larger but more shallow than the boxes used for wine grapes. The chief advantages of this box are that only one layer of fruit can be put in the box, thus preventing the pickers from filling the boxes too full, and crushing or spoiling the appearance of some of the fruit, and to permit the carrying of more fruit for a given weight of box. Where forty pound picking boxes are used the wagon must be piled very high in order to secure a load, while in the case of these special boxes the load is not so high from the bed of the wagon.

The chief disadvantage of this kind of box is that where the grape grower also has a crop of wine grapes to harvest he must provide two sets of boxes, one for table and one for wine grape. For this reason the average grower does not consider it advisable to have the two kinds of boxes.

Trays.- Trays for the drying of raisins come in various sizes and styles. The "Standard" tray, 18 inches wide by

36 inches long is perhaps the one most generally used now. The kind of tray is not so important, but economy of time in turning and stacking trays demand that they be of uniform size. The things which were said in regard to repairing of picking boxes, apply equally well to trays, and the loss of fruit from the use of broken or loose trays, will cost the grower more than the expense of repairing the trays.

Wagons.- The kind of wagon to use depends upon the size of the vineyard. The grower with a small acreage should endeavor to do all of his own hauling, and then hire his services to a neighbor, because the harvest time is the best chance for a farmer to make good wages with his team.

For hauling table grapes springs should be used on all the wagons in order to prevent bruising of the fruit, by hauling over the rough roads. These springs may easily be taken off when wine grapes are to be hauled.

The question of the size of wagon depends upon the number of acres that the grower operates. Where he has but a small place, a three ton wagon is usually sufficient, for unless he does considerable teaming for other people he will have but one team. On the larger vineyards a four or six ton wagon is used. Four animals may be said to be the draft as a rule; for, larger loads may be hauled, less men are needed, and the heavier wagons seem to be best adapted to the general ranch work.

The break-down of a wagon during the hauling season usually necessitates a trip to town, and causes general con-

fusion by delaying the pickers, and often requiring that fruit already picked will be allowed to remain in the field for some time. It is advisable, therefore, for the grower to examine his wagons closely to see that they are in good condition before the harvest season begins.

Tanks,- For hauling wine grapes heavy galvanized iron open tanks that set on the bed of the wagon are used. These are made water-tight, and so hold the juice that is pressed out by the jolting and weight of the load. By the use of a tank it is not necessary to haul boxes back and forth to and from the winery, and a much larger net load can be hauled. A tank wagon loaded at night will frequently have two or three inches of grape juice in the bottom of the tank by morning. For this reason it is essential that the tanks do not leak.

Labor.- The labor problem is the most difficult part of the harvest preparation. A large additional force of men is needed as soon as the harvest begins, and with the exception of a small force of men that may be kept during the year, the grower is dependent upon transient, or the help of his neighbors who may hire themselves and their teams out during this season. By promising steady work thru the harvest season, it is often possible to secure good men if the grower does not delay until the actual work commences. Many times the sons of some of his neighbors can be secured, or men who are known to be good workers, but it is not advisable to keep a man several months on the ranch doing odd

jobs unless he is well known to the grower, for he will often leave for slightly higher wages just when he is needed most. Furthermore, it is not advisable to hire a man for any particular kind of ranch work such as teaming, helping in the vineyard, etc., unless it is certain that he will be kept at that work during the season, for such an agreement may lead to a misunderstanding if for some reason, it is necessary to put the man at other work.

In hiring pickers on large acreages it is advisable to have a written contract with a reliable man who will furnish the required number. Often this is a Japanese or Hindu contractor who agrees to pick the fruit for so much a ton, and secures the best terms that he can with the men whom he hires. By putting the contract in writing the terms are clearly understood and there is less chance of dispute after the work has been begun. Here, again it is advisable to make a contract sometime before the harvest season starts, for the grower has a larger choice of men with whom he may contract, and often he may get the work done more cheaply.

Shipping grapes are usually picked by day labor, for if the picking is done as piece work, the laborer is usually over anxious to pick as much fruit as possible, and pays too little attention to the selection and care in handling the fruit.

Raisin drying may be contracted for so much a ton, in which case the grower agrees to pay for the raisins delivered to him in marketable condition. Another way is to pay so

much a tray for having the raisins picked, and for the drying by labor. There are growers who handle large crops of raisins in both ways, and so it would be hard to say which way is the best. If the owner does not live on the ranch it may be advisable to contract the drying; while if he lives on the ranch and especially if he has sons to help him with the work, he may find it more profitable to use the latter method.

All of the points mentioned here will doubtless have to be modified somewhat for each locality, and the best guide after all will be the methods used by men in a particular community who are making a success of the business, and who are operating on about the same scale, and under the same conditions as you are.

Table Grapes.

The harvesting of table grapes begins about the first of August, and may continue as late as the last of October or first of November, depending upon the variety, the part of the state in which the vineyard is located, and the intention of the grower regarding early and late shipment. There is a rush at the beginning of the season to try and get early fruit into the market, for the first few cars at the beginning of the season frequently bring very high prices. Later the grower picks his fruit at a moderate rate of speed, watches the market tendencies, and tries by suspending operations when the market is congested, or by diversion of cars enroute to reach the best markets. Frequently, the grape

grower can hold grapes that are situated on "late" soil, until the general glut on the market has been somewhat relieved and thus get his fruit in when other shippers are not so active. There is an element of risk in this practice though, for if the grapes are allowed to hang on the vines too long their attractiveness is lessened, and early rain may promote rot and reduce the keeping qualities of the fruit.

In the San Joaquin Valley raisin drying and wine grape picking begin early in September, and at this time it is quite difficult to get pickers who are willing to work by the day for the good picker is able to make more by doing piece work than the average grower is willing to pay for day work.

Perhaps it will not be too much to say, that the table grape requires more care in handling than any other grape in the vineyard. Most of the grapes are shipped out of the state and in order that they may arrive at their destination in good condition, it is essential that they be handled with care. Particularly is this so of that portion of the work carried on before the fruit reaches the packing shed. A close supervision of the picking and loading operation in the field is essential if one desires the best results.

Before the grower starts his picking operation he should examine his grapes with extreme care. Since he is anxious to get fruit into the market as early as possible he should be prepared to start as early as it is economically profitable to start picking. If his fruit is grown in a part of the state and on land such that it bids fair to be among the first

to reach the Eastern market, he can well afford to pay considerable picking charge for a small quantity of fruit. This will mean that the pickers will often have to go over several vines in order to secure a single bunch of ripe grapes.

On the other hand, if it has been possible for some other part of the state to start shipments sometime before the fruit in this section has attained the proper degree of sugar, he will usually find it advisable to wait until a considerable quantity of the fruit is ready to pick. The pickers can do more work in a day ; the fruit will usually have more sugar, and often more color; and these advantages may offset the gains made by getting a car of fruit into the market a few days earlier. In this connection it should be especially urged that the grower have his fruit on the vines until it has attained at least 18% of sugar.

After having decided to pick the grower should select the place where the grapes are the ripest, or where they are likely to dry most quickly, and distribute picking boxes along the avenues in proportion to amount of ripe fruit expected.

It seems best to have the pickers place a layer of leaves in the bottom of the boxes before the fruit is placed in so that it may not be bruised by hauling to the packing shed. If the haul is a very short one this precaution may be dispensed with.

In picking, the bunches are cut from the vines with a short bladed knife and placed in the boxes with the stems

pointing upward. This point should be insisted upon in order that the fruit may be removed by the packers with as little handling as possible. Pickers must not handle the fruit carelessly or rub their hands over it so that the bloom is rubbed off, for besides marring the appearance of the fruit, it also reduces its keeping qualities. Bruised, mildewed, or injured fruit is only good to dry and feed to chickens and pigs. Bunches containing many water berries, abnormally inflated berries, or small seedless grapes, except in true seedless varieties should also be rejected. If only a few misshapened berries are present in the bunch it may be picked for the packers can easily remove these berries with their scissors; but if such removal of berries will make the bunches long and stringy, they should be left on the vine to accumulate more sugar, when they may be sold to a winery, or dried for raisins.

Wherever possible the ranch wagon should be driven into the vineyard and the boxes loaded directly onto it, for this reduces the amount of handling, cuts down labor, and does not jolt the fruit as much. If this is not possible, the boxes should be hauled out of the avenues on a light vineyard truck and piled along the nearest main road. After loading the wagon a canvas should be placed over it to protect the fruit from the sun and to prevent too rapid wilting.

Usually two or three pickings are made over the same patch, but this will depend upon the season and earliness of the grapes. If the fruit ripens quickly enough to warrant

the expense of a very early picking as described before, it will usually be possible to go over the vineyard twice after this first picking. In this second picking the large and well ripened bunches that have the requisite amount of color and sugar are selected. Often there is little marketable fruit left for the last picking but if this fruit is left on the vines as late as possible, the small compact bunches of the second crop will be ripe and may often be shipped with profit since they arrive in market at the end of the grape season.

The fruit that is too stringy, or for some other reason can not be packed as table grapes, may be gathered for the winery. They usually bring a better price than the wine grapes and may yield considerable profit.

Raisin Grapes.

Before the raisin drying begins trays should be placed at the ends of the rows and the ground leveled. This is done by cultivating every other row or using a drag to break up the clods if any exist. Where the foliage is heavy it is cut back on one side of each row of vines so as to clear the alternate rows. The trays are placed at intervals along these rows when filled with fruit.

In all average seasons the raisin grape ripens the last week in August. At this time it will contain from 18% to 20% of sugar, and seems perfectly sweet to the taste, but if the fruit were picked at this time it would be of inferior quality. The grape, therefore, is allowed to hang on the

vines for a week or ten days longer, or until it has from 25% to 28% sugar.

The results of an experiment carried on by the California Experiment Station at Berkeley, to determine the relation of the degree of ripeness of the grape to the quality and quantity of the crop of raisins, shows that grapes of 29 Balling degrees of sugar yielded 60% more raisin than grapes of 21 Balling degrees of sugar, and that the increase in the crop of raisins per acre corresponding to this degree of ripeness, was 45%.

It is better in every way to have plenty of sugar in the grape when it is picked, for even though picked later in the season, the 28% grape will be cured before the 21% grape, though the latter was picked a week earlier.

The trays hold 22 pounds of green grapes which dry out to between six and seven pounds. After being picked and placed on the trays, the grapes are allowed to dry out between the rows of vines for two weeks or longer depending upon the weather. At this time the temperature in the sun is about 120°F. and so it is quite possible to cure the grapes in this way.

At the end of ten days or two weeks the raisins are turned by placing an empty tray on top of a full one and turning it over. After being turned the raisins are allowed to dry in the sun for about one week, and are then stacked. The cleats on the trays allow of sufficient circulation to finish the drying. Before being stacked the raisins are entirely

colored, but there is still a very small amount of moisture left which is dried out after two or three weeks in the stack.

When the raisins are cured they are put in sweat boxes, or flat boxes that hold about 200 pounds of fruit, and delivered to the packer.

Wine Grapes.

In the San Joaquin Valley wine grape picking begins early in September and continues thru October. The wineries prefer grapes from 20% to 24% of sugar, depending upon the variety but it is quite possible to have them run two high in sugar.

The pickers usually place a box under a vine and cut the bunches of grapes from the vines allowing them to fall into the box. As each box is filled it is carried out to the avenue where it is loaded into a tank wagon. But little care is required in picking wine grapes except to see that the pickers do not leave the small bunches on the vine, and to insist that the different varieties of grapes be kept separate when the wagons are loaded.

CHAPTER XIII

Insects Affecting the Grape.

Insects that affect vines may attack the roots, the trunk and canes, or leaves. Where these insects appear above ground and chew the leaf or cane they may usually be controlled by a solution of arsenic, but where they feed on the roots of the plant without coming to the surface during any of the stages of their development, they are very difficult to control. Where insect enemies live on the roots of the vine they usually do not migrate to any great extent, and so by pulling up the vines that are infected they may be checked. In other cases a resistant stock has proved the solution to the difficulty.

Knots and Galls on the Roots of Grape Vines.- Irregular shaped fleshy knots often appear on fruit trees and vines on and above the crown of the roots. This form is often known as "Black Knot" where it occurs on the grape.

Besides the Crown Gall, there are four other kinds of galls that the grape grower should be familiar with.

1. Mechanical Galls that are formed at the point where some roots meet obstruction such as stones. These are smooth and only accompany an abrupt bend in root, and are not often found near the crown.

2. Louse Galls due to the attacks of plant lice such as phylloxera and woolly aphis. Such galls are small in size, occur on small and large roots, and on the crown as well as elsewhere. The presence of the lice is usually a sufficiently

distinguishing character altho they may not be observable.

3. Club-footed Galls produced by a slime mold (*Plasmodium brassacei*) on the roots of cabbages and such plants.

4. Nematode Galls which are due to minute worms. The worms can not be seen without a cross-section under the microscope, but the small size of the gall, and its presence chiefly on the small roots will distinguish it from Crown gall.

It has been variously believed that these galls were the results of wounds made in cultivation; that they were due to particular weather conditions; and that they are caused by some of the fungi. The real cause of this gall is not known but the effect is to impede the flow of sap, and ultimately to kill the vine.

Remedy.- Remove and burn the knots as soon as found and apply an antiseptic such as Bordeaux to the vines where the knot has been removed. If the knot reappears it will be best to destroy the whole vine.

In the nursery the greatest care should be taken to destroy, by burning, everything showing an indication of galls. Fields where galls have occurred should be devoted to some other crop for a few years.

Phylloxera.

This insect has effected a considerable portion of California, but the slowness with which the disease spreads has rendered the southern part of the State, and the San Joaquin Valley, free from this trouble. The distance between grape growing areas, the resistance of such varieties as the Flame

Tokay, and the rich soils, have tended to prevent the rapid dissemination of phylloxera.

The phylloxera are of two forms, the winged and the wingless. The former are rare in California because of the absence of rains in June and July. The latter form can only spread by being transferred on cuttings. Therefore, it is necessary for each grower to take precaution to disinfect cuttings before planting, and to see that no infected cuttings are sent out from his vineyard.

Cultivation is one of the most effective means of carrying the insect from one part of the vineyard to the other.

Disinfecting the Cuttings.- Carbon bisulphide is the best method for the grape grower. The cuttings should be placed in an air tight barrel or box and a saucer of bisulphide of carbon placed on top of them. The container should then be covered with an oiled canvas, or tight fitting cover, and should be allowed to stand for from 45 to 90 minutes, cut about one half inch from the end of the cutting before planting. Practically it is impossible to disinfect rooted cuttings on account of the difficulty of killing all of the phylloxera without killing the roots.

Disinfection of Roots.- Dipping the roots in hot water (125° F. to 130° F.) for ten minutes is sufficient to kill the lice. It is probable that disinfection by hydrocyanic acid gas as practical for nursery stock would be effective, but no data is at hand.

Delaying the Spread of Phylloxera.- When phylloxera has

first entered a vineyard it can not be found until it has weakened some of the vines. It can not be eradicated, but much can be done to prevent its spread. . Dig up all of the dead and weak vines and a block surrounding them including at least three rows of apparently healthy vines on all sides. The vines should be covered with coal oil for several months thru the summer, as they are piled up, and finally burned. Another way is to make holes twelve inches deep, spaced eighteen inches apart over the infested area, and pour about one and one half ounces of carbon bisulphide in each of them, after which they are covered with dirt. If the vines survive the first treatment an ounce of the carbon bisulphide may be again applied three weeks later into each of the holes.

Reestablishment of a Vineyard.- When a number of places and considerable portion of the vineyard have become effected the only thing left to do is to take up blocks of the old vines and plant the bench grafted resistant varieties.

Planting the New Vineyard.- In planting in new soil, if there is little likelihood of the vineyard becoming infested with phylloxera, it would save from \$30 to \$40 per acre to plant the Vinefera on their own roots; but if there is danger of phylloxera infestation, the resistant stocks should be used.

The Grape Root Worm. (*Adouxus Vitis Fourcroy*).

This beetle has commonly been known as a flea beetle, but since it neither jumps nor lives like the flea beetle, it would be more correct to call it the Grape Root Worm.

Life History.- The adult beetle appears in May after passing thru the larval and pupal stages in the ground. It feeds upon the green parts of the plant and eats slits in the leaf from a quarter to three quarters of an inch in length.

Egg-laying begins about two weeks after the beetle has hatched. They are laid in crevices below the old bark, and may range from four to thirty-five in number. The eggs hatch in from eight to ten days, and the young larvae crawl to the ground and feed on the roots. The larvae feed on the roots during the entire summer, and remain dormant thru the winter. In the spring they change to pupae and emerge as beetles about May first.

Vines attacked in this way show a stunted condition, the canes failing to attain normal growth, and in some cases the vines may be killed outright.

Control Measures.- The beetles are readily jarred from the vines, and can be controlled if something is put under vine to catch them. The hopper cage as used for the vine hopper, has proved successful in this case. If only the beetle is to be caught, the tray on the bottom of the cage is all that is necessary.

Arsenate of lead, five pounds to fifty gallons of water, or Paris Green, one pound to one hundred gallons of water, is effective.

Thorough stirring of the ground for two or three feet around the base of the vine to a depth of six inches has seemed to be effective in controlling the beetles when they were in the pupae stage.

Hawk Moth Larvae.-

These caterpillars are found on the vine in May and June. The larvae are green in color and may be distinguished by a large horn on the posterior end of the body.

The insects hibernate in the pupae stage and come out about the middle of May as the large moths that are found in flower beds at dark. The eggs are layed on the vine, and when the larvae hatch they immediately begin to feed on the grape foliage. They are heavy feeders, and may grow two or three inches in length. It is thought that there may be two broods a season.

Control Measures.- When there are only a few in a vineyard they may be picked off by hand. When there are great numbers, however, spraying with arsenicals at the time the pupae hatch will kill them before they can do much damage.

It has been suggested that the moths that hover around the flower beds may be poisoned or caught in traps. It seems to be rather a question as to just how many would be caught in this way.

Grasshoppers.

The grasshoppers do considerable damage at times and may even defoliate a whole vineyard in bad cases.

The eggs are laid mostly on uncultivated ground during the late summer and hatch the following spring. The young grasshoppers are similar to the adult except that the wings are lacking. These are acquired by successive molts.

Control Measures.- Since the grasshopper eats the foliage

of the vine, he may be controlled by poisoned bait; spraying a few rows on the border of the field; burning waste feeding areas; or introducing turkeys. Perhaps the most common method of control is mixing bran, molasses, and arsenic and distributing this over the vineyard. The proportion is 40 pounds of bran, two gallons of cheap molasses, and five pounds of arsenic. Cheap glycerine may be used to keep the mixture from drying. If the grasshoppers enter in swarms, poison the first few rows in the direction from which they are entering the vineyard. Turkeys are good to destroy grasshoppers unless they are too abundant. The turkeys are turned into the vineyard for a couple of hours every morning and evening, and kept in a cool barn during the day.

Cut Worms and Army Worms.

These worms may appear in small numbers, or march as a regular army, in search of food, hence the name. Some of these worms climb up the side of the vine and cut the buds, while others cut the shoots as they emerge from the ground.

The Cut Worms and Army Worms spend the winter as partly grown larvae, and become active in the spring. When they become full grown they drop to the ground where they change to pupae, and after remaining in this stage two or three weeks they hatch and become adult moths. The eggs are laid on grasses. From these the larvae hatch and start growth until by fall they are about half grown. In California there are two generations a year.

The worms feed mostly upon grasses, but when the grain

becomes dry in mid-summer they attack and defoliate vineyards, and also cut off the unripe bunches.

Control Measures.- Placing around the base of the vine the same ingredients as are used for killing grasshoppers will prove effective, for the poison will be eaten by the worms in preference to climbing up the vines.

Where they attack in armies, a furrow should be plowed along the side of the vineyard from which they attack. The furrow should be plowed as deeply as possible with the vertical side along the vineyard. Above this, fine pulverized earth should slope as abruptly upward as possible. Post holes should be dug every fifteen feet at the bottom of the furrow so that the worms may fall into them as they crawl along. Crude oil or kerosene may then be poured into the holes, or a strip of crude oil poured in the bottom of the furrow.

If they get into the vineyard, the affected vines should be thoroughly sprayed with lead arsenate, five pounds, water fifty gallons; or Paris Green one pound, water seventy-five to one hundred gallons. Under these conditions a furrow should be plowed around the infested regions to prevent the further spread of the worms.

Flea Beetles.

The Flea Beetle of the grape is of a bluish color, and about one fifth inch in length. This beetle is capable of jumping while the black or brown beetle can not. The Flea Beetles winter among dry leaves, and feed upon the buds of the

grape in the spring. In their seeding they may eat the entire bud, or only gouge out the center. The eggs are laid in crevices of the bark, and when the larvae hatch they eat holes in the leaves for two or three weeks, after which they drop to the ground and enter the pupae stage. In about two weeks the second brood of beetles emerges.

Control Measures.- These beetles can be killed by using poisoned spray, either Paris Green or lead arsenate; or they may be jarred from the vines and caught in the same way as the root beetle.

Grape Leaf Folder.

The Grape Leaf Folder may be easily recognized, for it rolls up about half of the leaf in such a way as to make a tube less than the diameter of a lead pencil in which the larva lives. The larva feeds by eating off the inner portion of the leaf that is used to make the tube in which it lives. The larva lives in a chrysalis and lays its eggs upon the vine in the spring. The larva of the first brood appears about the first of June, and when full grown is a greenish white caterpillar about an inch in length. The moth is nearly an inch across when the wings are expanded, and is black with white markings.

Control Measures.- The only effective means of control is to spray with arsenate of lead, or Paris Green before the folder rolls up the leaf. If they are not too abundant, hand picking or crushing the folded portion of the leaf will be the most practical.

Leaf Chafers.

The larvae feed on the roots of grasses in the early stages but later come to the surface and change to pupae. Two or three weeks later they emerge as adult beetles and attack the vines. A sandy soil is especially adapted to their underground habits. After feeding for two or three weeks they deposit their eggs on the ground. From these eggs the next generation hatches.

Control Measures.- Paris Green or lead arsenate should be used in liberal quantities since the insect is hard to control. The jarring method as used for the root beetle will also prove helpful.

Grasses and weeds in ditches, around vines, and on the edge of the vineyard, should be cleared away.

Wire Worms.

These worms, as the name indicates, resemble a piece of wire, being long, dark brown, and leathery. They feed on the roots of plants, and when they occur in large numbers do considerable damage to the vineyard. The adult of the wire worm is the large, black "Click" beetle.

If vines follow a hay or pasture crop, the worms are apt to attack and girdle the vines. They are particularly injurious to the roots of *Rup. Petris St George*.

Treatment.- There seems to be little to suggest in the way of remedy. Clean culture will do as much as anything, for it removes the roots of grasses, and much of the feeding area close to the vine. If the worms collect around the vine, and

can be recognized before they girdle it, they may be controlled by digging down two or three inches and removing them by hand.

Erinose.

Erinose is a disease of the vine characterized by swellings on the upper, and depressions on the lower surface of the leaf. The depressions on the lower side are covered with a woolly substance that is white at first, but turns yellow later. A microscopic examination shows that these are abnormally developed hairs on the surface of the leaf which cause them to grow out in this manner. The injury to old vines is not sufficient to interfere with the crop, although at times it may tend to prevent the proper ripening of the canes. In young vines the effect may be more serious. It attacks Tokays readily, and has been found more or less abundantly on Mission, Zinfandel, and Muscat grapes.

Treatment.- Where sulphuring is practiced two or three times during the year, Erinose is well controlled, for the mites can not stand the sulphur fumes. In winter such trouble is handled by pouring a quart or more of boiling water over the stump of the vine. Cuttings affected with the mites should be placed in hot water (122° F) for at least ten minutes.

Nemotode Root Gall.

These are small worms about one seventy-fifth of an inch long that attack the roots by means of a sharp slender organ on its head, that enables it to make its way into the soft tender portions of the root. Here it develops and lays its eggs.

The swellings caused are somewhat like those of phylloxera, but are mostly upon the larger roots, while those of phylloxera are principally upon the smaller ones. The swellings are also firmer than those of phylloxera.

Moisture is probably the most important factor in favoring the development of this worm. This pest seems to be most abundant in sandy soils, for in California it is most common on vines in the Fresno section, and in general, this is a section of sandy soil.

Control Measures.- There is no satisfactory control for this trouble. Disinfection of the soil is sometimes practiced before planting, by means of carbon bisulphide. It has been suggested that a resistant stock is the solution, but such a stock has not been found up to date.

The Grape Leaf Hopper.

The Grape Leaf Hopper was first reported in California in 1875, and since that time, with the exception of Phylloxera, it is the most destructive insect pest in the state.

The Hopper belongs to the class of "sucking insects" that are equipped with sucking mouth parts. The sharp pointed beak of the hopper is thrust into the tissues of the grape leaf, from which it extracts the liquid parts. The feeding is done mostly around the inside of the leaf, and the leaves around the base of the vine are the ones first attacked.

The first indication of attack is a mottled appearance due to pale spots where the beak has been inserted, and the chlorophyll removed. Finally, so much of the green material

of the leaf is removed that the leaf turns pale and drops off. This has been noted as early as April and May. In these cases the vine is prevented from making the normal growth. This drying of the leaves prevents the fruit from ripening properly, and results in sunburn. In addition, it prevents proper ripening of the canes and buds, and may result in the death of the vine.

In California the American species is found in practically all of the vine growing districts, but is most injurious in the Sacramento and San Joaquin valleys.

Life History and Habits.- During the winter weather the hoppers are found in great abundance on leaves, weeds and grass over the vineyard, and are also found in large numbers under the low spreading foliage of *Alfilaria*.

The hopper feeds on a large number of plants during the winter. It feeds during warm days, but is more or less dormant on cold, or rainy days. *Alfilaria* forms perhaps the principal food of the hoppers; burr clover, rag weed, dock, wild mustard, and several kinds of grains and grasses are all utilized for food.

Egg laying begins the first week in May. The hopper lays about one hundred eggs a day and from eight to twelve days is required for them to hatch. For those that are laid in the fall, and serve to carry the hoppers over the winter, from seventeen to twenty days is required. Usually only about fifty percent of the eggs laid develop into nymphs. The young hoppers differ from the adults chiefly in the fact

that the wings are not fully developed. These are acquired in the successive five molts. The average time required to go thru these five molts is eighteen days.

Control Measures.- Various kinds of sprays, torches, fumigation devices, and suction devices, have been used, but each has shown some defect that rendered it impractical. Finally, a screened cage was devised by means of which the hoppers could be caught. This has proved to be the most successful means of catching the hoppers yet tried.

A screen is made with ordinary galvanized iron mosquito netting. The bottom of the tray consists in turning up about an inch and a half of the edges of a sheet of light galvanized iron. One side of the box is kept open, and there is a "V" in the tray at the bottom which permits the cage to be pushed onto the vine. The sides and bottom of the tray are smeared with crude oil to catch the hoppers which fall on them. The cage is swung into position, and the vine is bumped by the base of the opening which is padded with leather. The hoppers drop from the vines and are stuck to the crude oil.

The cage should be used early in the spring when the shoots are from four to five inches long. This catches the hoppers before they have begun to breed, and greatly reduces the number of the succeeding generations. If this screened cage is conscientiously used it will capture from 85% to 95% of the hoppers.

CHAPTER XIV.

VINE DISEASES.

Anaheim Disease.

This trouble originated around Anaheim, California, and has destroyed several thousand acres of vineyard in the state. Just exactly what the nature of the disease is has not yet been determined, but it is believed to be due to some unfavorable condition such as chlorosis which is a failure to develop chlorophyll, and to an excess of soluble lime carbonate in the soil. Since this trouble is due to soil and climatic conditions which weaken the vine, they are to be combated by cultural methods which strengthen and invigorate the vine. Short pruning, thorough cultivation, irrigation or drainage, and fertilization, will in most cases be effective in curing vines which are not too far gone.

Anthracnose.

This disease occurs on shoots and berries, but may also appear on leaves. At first the spots are light brown but later they sink ⁱⁿ, becoming somewhat pitted, and a band of purple is formed around the depression.

Control.- The usual spraying as for Black Rot does not necessarily affect anthracnose, and when it occurs it is best to cut out and burn the affected canes.

Black Knot.

This is one of the most common and widely distributed diseases of the vine in California. It consists in swelling on the upper part of the roots, or lower part of the trunk

or branches, but rarely on the young canes. The knots do not do much harm unless they attack young vines, or older vines very severely so as to girdle them. This will not always result in death, but the vine will become weak and worthless. These knots occur only on vines growing in moist places, and especially on sandy soils in warmer localities. Anything which encourages vigorous growth late in the season prevents proper ripening of the wood, and exposes the vine to this disease.

The remedies for black knot are drainage of soil, fertilization with phosphate manures, longer pruning, raising the trunk of the vine, and removal of knots.

Black Rot.

This disease develops most rapidly in warm moist conditions, and so would not do much damage in the hot dry interior valleys. However, it is quite possible that it is a source of trouble in the moist coast valleys.

The fungus occurs on the young shoots and upper parts of the leaves in spring, and is characterized by reddish brown spots from an eighth to a quarter of an inch in diameter. In the case of the fruit, a whitish blister is formed which later turns black, and spreads over the entire berry causing it to shrivel and harden. The spores remain over the winter in the diseased leaves and berries on the ground.

Control.- All diseased parts should be removed. Deep plowing in spring to cover berries and leaves, and cultivation to keep down weeds and grass will prove helpful. Spray

thoroughly with Bordeaux 4x4x50 when the leaves unfold; again when the blossoms swell; and a third time when the blossoms fall.

The question of spraying will have to be determined by the individual conditions. In dry regions like the interior valleys, it is likely that this disease will do but little harm, if nothing is done, while in the warm moist valleys near the coast it may be necessary to spray several times during the season.

Coulure of Muscats.

This is a dropping of the blossoms of the vine before the fruit sets. The first crop is most subject to this trouble. The causes assigned for coulure are; unfavorable weather, improper pruning, fungus attacks, unsuitable and improper soil. The primary and essential cause, however, lies in the structure of the flower itself. There are defects in the structure of the Muscat flower which makes pollination more uncertain than with other varieties, and it is only under the most favorable conditions that the ovules are properly fertilized. The filaments are short, and so placed that pollen may fall off without reaching the stigma, furthermore, the pollen is waxy, and has a tendency to cohere in masses, thus making wind distribution difficult.

Remedies.- It is advisable to plant other varieties having abundance of strong pollen, among the Muscat vines. Most of the varieties cultivated in the raisin districts blossom about the same time as the Muscat, and such varieties

as Polomino, Perruno, Baba, and Purgol, which always set their fruit well, will be suitable for the purpose.

Powdery Mildew.

Powdery mildew is perhaps the most destructive vine disease that the California grape grower has to combat. The fungus attacks all parts of the vine and appears as white patches about a quarter of an inch in diameter, on the upper or lower surfaces. If this continues until the leaf is covered it curls up and dies.

After the grapes have lost their green color and commenced to ripen they are not attacked by mildew. If attacked early in the season so that they are prevented from attaining their normal size they will be of little value for shipping purposes, but may be used for wine making.

The irrigated districts are not so subject to mildew as are the coast regions where fogs and moisture are more abundant, but in irrigated districts and near swamps it will be seen to be quite prevalent. The fungus does not develop below 50° F., and grows slowly up to 75°. Above this temperature it develops rapidly and reaches its maximum growth between 90° and 95° F. At 100° F. it ceases to develop, and is destroyed above this temperature.

Control.— The only method that is really satisfactory for the control of the mildew is the application of powdered sulphur sprinkled over the vine. The sulphur fumes destroy the mycelium of the fungus, and will remove all of the mildew except the perithecia.¹

¹. California Bulletin No. 186.

In order that the sulphuring may be effective, it is essential that it be applied when the temperature is high enough to produce the fumes, and that it covers every part of the vine.

CONCLUSION.

Each detail of the farm operation needs prompt and careful attention, and must be handled with the same care as the details of a city business. It is hard to figure in dollars and cents just what it costs the fruit grower to delay cultivation after a rain, or to fail to sulphur at the right time. Until he realizes, however, that each hour delayed in the doing of some important farm operation means a direct loss, just as though it were taken out of his savings, he will fail to make the most of the vineyard business.

The business side of farming has been sadly neglected in many cases; and too many men trust to memory in their farming operations, rather than to a good system of books. If a vineyard is to be run efficiently, the operator must know what the different operations cost him, and whether by engrafting or replanting certain portions the income may not be increased. The work must be systematized, and must run smoothly, or the grower will nearly always be the loser. Especially is this so where he employs a large number of men. A loss of twenty minutes a day actual working time on the part of the men results in considerable total loss, and where one is paying by the day he can easily determine what such a loss of time, continued thru the harvest season will cost him. The vineyard is truly a factory and small losses must be kept at a minimum if the enterprise is to be fully successful.

Finally, the grape grower must be more of a co-operator.

He is trying as an individual to deal with the well organized markets of the country. He ships his grapes thru a company; until recently his raisins went to one of several private raisin packing companies, and his crop of wine grapes to the California Wine Association, or some independent winery. The question is not "What will you take for your crop?"; it is, "How much will you pay me?"

Are these independent companies in the business for their health?

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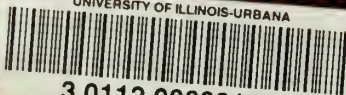
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